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Recommendations from Value Engineering Studies on Wastewater Treatment Works

(U.S.) Culp/Wesner/Culp
El Dorado Hills, CA

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This publication summarizes the best ideas/recommendations from 93 value engineering (VE) reports which were completed under EPA's mandatory VE program for 75 construction grant projects. Data abstracted from these reports provided the basis for an overall evaluation of the VE program. Application of VE ideas/recommendations and evaluation results presented in this publication should enhance the effectiveness of VE in the design of future wastewater treatment facilities.

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RECOMMENDATIONS
FROM
VALUE ENGINEERING STUDIES
ON
WASTEWATER TREATMENT WORKS

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ABSTRACT

This publication summarizes the best ideas/recommendations from 93 value engineering (VE) reports which were completed under EPA's mandatory VE program for 75 construction grant projects. Data abstracted from these reports provided the basis for an overall evaluation of the VE program. Application of VE ideas/recommendations and evaluation results presented in this publication should enhance the effectiveness of VE in the design of future wastewater treatment facilities.

FORWARD

Since the mandatory value engineering (VE) program was initiated in October 1976, it has produced substantial construction cost savings and a high rate of return for the VE investment. The program has saved an average of 5.1 percent of the construction costs on projects which required VE studies. Stated another way, the VE program has achieved a $12 return for each dollar invested in VE costs.

This publication represents the Environmental Protection Agency's (EPA) continuing efforts to evaluate and improve the effectiveness of the VE program. The publication summarizes the best ideas/recommendations from 93 VE reports completed under EPA's mandatory program and presents general information for improving the future performance of the program.

This publication does not present any regulatory requirements. The requirements and guidance for conducting VE studies on EPA funded projects are contained in Section 35.926 of the Construction Grants Regulations, the Value Engineering Workbook (MCD-29) published in July 1976, and the Value Engineering Case Studies and Formats For Proposals and Reports published in June 1977.

This publication is designed to serve as a reference source for wastewater treatment design engineers and VE study teams in their efforts to improve the quality of future treatment facilities while minimizing the construction and operational costs.

The Environmental Protection Agency intends to continually evaluate and improve the VE program. Therefore, all users of this publication are encouraged to submit any pertinent information on the VE program to the Director, Municipal Construction Division (WH-547), Office of Water Program Operations, U.S. Environmental Protection Agency, Washington, D.C. 20460.

Eckardt C. Beck
Assistant Administrator for
Water and Waste Management (WH-556)

TABLE OF CONTENTS

	Page
Disclaimer	
Notes	
Abstract	
Forward	
Chapter 1 - Introduction	1
Background	1
Purpose and Scope	2
Description of VE Studies	2
Criteria Used for Selection of VE Recommendations	4
Recommendations on Conducting VE Studies	5
Chapter 2 - Basins and Tanks	7
Shape	7
Size	13
Materials	14
Design Concepts	15
Chapter 3 - Process Equipment	23
Flow Equalization	23
Pumps - Influent and Effluent	27
Pumps - Process	33
Flow Measurement	43
Screening	44
Grit Removal	45
Clarifiers	49
Trickling Filters	52
Aeration System (Including Pure Oxygen)	53
Disinfection	65
Filtration	68
Post Aeration	70
Chemical Feed	71
Sludge Collection	73
Sludge Thickening	74
Sludge Dewatering	78
Sludge Stabilization	82
Sludge Disposal	87
Chapter 4 - Site Layout (Plant and Equipment)	89
Earthwork	89
Roads	92
Piping	94
Equipment and Process Layout	107
Hydraulics and Hydraulic Gradeline	113
Miscellaneous	116
Chapter 5 - Buildings or Structures	117
Size	117
Location	119
Materials	123
Floor Plans	124
Type of Construction	127
Appurtances	136

TABLE OF CONTENTS (Continued)

Page

Chapter 6 - Electrical, HVAC and Controls 137
    Power Distribution 137
    Instrumentation 142
    Control 146
    Lighting 150
    HVAC 151
Chapter 7 - Energy 153
    On-Site Generation 153
    Heat Recovery 154
    Conservation 156
Chapter 8 - Aesthetics 159
    Odor Control 159
    Noise Control 166
    Architectural 164
Chapter 9 - Constructability 167
    Structural Details 167
    Construction Sequencing 170
    Materials 171
Chapter 11 - Sewers 175
    Manholes 175
    General Construction 176
Chapter 12 - Interceptor System Pumping Stations 177
    Structure 177
    Emergency Generator 178
    Piping 179
    Design Concepts 181
Chapter 13 - Ocean Outfall 182
    Covering Material 182
    Construction Material 185
    Construction Technique 186
    Design Concept 187
Appendix A - Value Engineering Program Evaluation A-1
    Productivity of VE Teams A-1
    Potential VE Savings A-2
    Acceptance of VE Recommendations A-6
    Identification of High Cost Components A-11
    Composition of VE Teams A-13
    Cost and Level of Effort for VE Studies A-14
    Reasons for Rejection of VE Recommendations A-18
    General Observations A-19
Appendix B - Ideas Applicable to Most Wastewater Treatment Projects B-1
    Design Criteria B-1
    Site Work and Layout B-2
    Site Buildings B-3
    Structural B-4
    Equipment B-4
    Mechanical B-5

TABLE OF CONTENTS (Continued)

Page
Appendix B - Ideas Applicable to Most Wastewater Treatment Projects (cont.)
Electrical and I&C B-5
Energy Conservation B-6
Miscellaneous B-7

LIST OF TABLES

Page

1 RESULTS OF VALUE ENGINEERING PROGRAM 1

2 DISTRIBUTION OF VALUE ENGINEERING REPORTS 2

3 TREATMENT UNITS AND MISCELLANEOUS FACILITIES EVALUATED IN VE PROGRAMS 3

4 DISTRIBUTION AND STORAGE OF DESIGN COMPLETION OF WORKSHOPS 4

LIST OF FIGURES

		Page
1	Change wye wall to tee wall.	8
2	Reduce length of dividing walls.	10
3	Square clarifiers instead of circular.	11
4	Square clarifiers instead of rectangular.	12
5	Common wall construction between chlorination and post aeration.	17
6	Simplify chlorine contact tank valving.	18
7	Use outboard launders.	19
8	Substitute earthern basin for concrete basin.	25
9	Revise inlet to pumping station.	28
10	Right angle drive system.	29
11	Vertical turbine pumps.	34
12	Combine pumping stations.	36
13	Pump primary effluent directly to bio-filters.	37
14	Use mixed flow pumps in lieu of screw pumps.	39
15	Use vertical mixed flow pumps.	40
16	Use vertical mixed flow pumps instead of screw pumps.	41
17	Exchange grit channels for Pista grit chambers.	46
18	Simplify grit removal.	48
19	Replace primary effluent channel with pipe.	50
20	Replace low pressure air scum control system with collection mechanism.	51
21	Emergency drive for pure oxygen air compressor system.	54
22	Use dual drives for blowers.	56
23	Replace swing drop pipes with lift out drop pipes.	58
24	Use complete mix activated sludge.	61
25	Replace mixed liquor channel with pipe.	63
26	Replace control valves with telescoping valves.	76
27	Use precast concrete walls.	80
28	Design sludge drying beds for mechanical equipment.	81
29	Mechanical mixing in anaerobic digesters.	83
30	Replace retaining wall with precast panels in H-piles.	91
31	Simplify return activated sludge flow balancing scheme.	95
32	Reduce length of yard piping.	98
33	Delete drain pipes and gates from head end of aeration basin.	100
34	Relocate flow splitter box.	101
35	Simplify mixed liquor piping.	102
36	Use single mixed liquor pipe to secondary clarifiers.	105
37	Simplify scum handling system.	106
38	Scrubber water recycle streams.	108
39	Modular design of unit processes.	110
40	Relocate odor scrubber outside building.	112
41	Raise influent screw pumps.	115
42	Eliminate sludge conveyors.	120
43	Simplify gravity sludge thickening system.	122
44	Use reinforced concrete pipe for tunnels.	129
45	Use insulated steel siding for buildings.	131
46	Substitute acoustic metal panel for "Sound Blox".	132
47	Use fiberglass covers over tertiary filters.	133

LIST OF FIGURES (continued)

Page
48 Dissolved oxygen control system. 145
49 Reduce size of main control room. 147
50 Install heat exchangers on effluent sludge line. 155
51 Extended pump discharge pipe below water surface. 157
52 Use two-stage carbon for odor control. 161
53 Wall strut system. 168
54 Use steel framing. 172
55 Use "Shotcrete" fixed cover on anaerobic digester. 174
56 Use force main instead of gravity interceptor. 180

CHAPTER 1
INTRODUCTION

BACKGROUND

Value Engineering (VE) was first introduced into the EPA Construction Grant Program on a voluntary basis in 1974 based on the success of this cost control technique in other Federal agencies. VE was described as a "systematic and creative approach to identify unnecessarily high costs in a project in order to arrive at a cost savings without sacrificing the reliability or efficiency of the project or increasing operating and maintenance costs." The success of the voluntary program was measured in terms of the following:

- Effective in cost control
- Substantial cost savings achieved
- Project delays can be avoided
- Quality and reliability maintained
- Provides for more efficient and better design techniques.

This success prompted the EPA to institute the mandatory VE program in 1976 which required all projects with a total estimated construction cost (excluding the cost of sewers) of $10 million or greater to have value engineering. Projects with lower estimated construction costs still are encouraged to participate in the VE program on a voluntary basis.

The summary results of the voluntary program and the mandatory program for fiscal years 1977, 1978 and 1979 are presented in Table 1. This table clearly shows that the mandatory VE program has been successful when measured in terms of the net savings. The program has realized an average savings of 5 percent in project costs and a net capital savings to VE costs ratio of more than 12 to 1.

TABLE 1. RESULTS OF VALUE ENGINEERING PROGRAM

Fiscal year	No. of VE projects	Total capital project costs $1,000's	VE costs[1] $1,000's	Net VE capital savings $1,000's	Net savings %	Savings cost ratio
Pre-1977[2]	8	450,000	700	18,000	4.0	25.7:1
1977	28	1,426,700	6,354	73,604	5.2	11.6:1
1978	28	501,807	1,660	21,871	4.4	13.2:1
1979	31	807,220	3,287	45,182	5.6	13.8:1

[1] Includes VE fee and implementation costs

[2] Voluntary program

PURPOSE AND SCOPE

The purpose of this publication is to present a reference document of the most worthwhile ideas or recommendations from 93 Value Engineering reports prepared for 75 projects under EPA's mandatory VE program. This publication is intended for use by design engineers and future VE teams as a "memory jogger," either for specific ideas or to stimulate alternative suggestions and ideas.

A secondary benefit of examinating such a large spectrum of VE studies was the opportunity to conduct a general evaluation of the VE program. This evaluation should provide an excellent basis for improving the effectiveness of future VE studies. The details of the evaluation are presented in Appendix A.

DESCRIPTION OF VE STUDIES

All of the VE studies were conducted on "mechanical" wastewater treatment facilities, pumping systems, sewers, outfall systems. A VE analysis of a land application system has not yet been conducted under the mandatory VE program. The capacity of the wastewater treatment facilities studied in the VE program ranged from 1 mgd to 160 mgd average daily flow, as shown in more detail on Table 2. The estimated pre-VE construction costs ranged from about $3 million to $250 million.

TABLE 2. DISTRIBUTION OF VALUE ENGINEERING REPORTS

EPA Region	Number of projects evaluated	Treatment plant size <1 MGD	1-10 MGD	10-50 MGD	>50 MGD	Outfall	Sewer or P.S.
1	6	-	-	6(5)[1]	-	-	-
2	5	-	2	1	-	1	1
3	4	-	1	3	-	-	-
4	17	-	1	16(6)	-	-	-
5	14	-	1	9(6)	2(2)	-	2
6	2	-	1	1	-	-	-
7	3	-	1	1	-	-	1
8	2	-	-	2	-	-	-
9	17	-	3	6(1)	4	-	4
10	5	-	3	2	-	-	-
Total	75	-	13	47(18)	6(2)	1	8

[1] Number in parenthesis designates number which include AWT.

The wastewater treatment and solids handling process and miscellaneous facilities included in the VE studies are presented in Table 3. This shows the large variety of treatment processes that have been evaluated over the past few years under the mandatory VE program. By far the majority of the wastewater treatment plants were activated sludge systems designed to produce better than secondary effluent quality, typically 20 mg/L BOD_5 and 20 mg/L suspended solids or better. Solids handling generally centered around waste activated sludge thickening, anaerobic digestion, sludge dewatering and landfill of the stabilized residue.

TABLE 3. TREATMENT UNITS AND MISCELLANEOUS FACILITIES EVALUATED IN VE PROGRAMS

Wastewater treatment

Flow equalization
Flow measurement
Screening
Grit removal
  - Aerated
  - Constant head
  - Constant velocity
Pre-aeration
Influent pumping
  - Electric driven
  - Engine driven
Primary sedimentation
Biological treatment
  - Activated sludge
  - Trickling filter
  - Rotating biological contactor
  - Pure oxygen
Secondary sedimentation
RAS pumping
Effluent filtration
Disinfection
  - Chlorine
  - Ozone
Dechlorination
Nitrification
Phosphorus
  - Chemical addition
  - PhoStrip

Solids handling

Raw sludge pumping
Gravity thickening
WAS pumping
WAS thickening
  - Dissolved air flotation
  - Centrifuge
  - Belt press
Sludge stabilization
  - Anaerobic digestion
  - Aerobic digestion
  - Lime addition
Sludge dewatering
  - Vacuum filtration
  - Belt press
  - Centrifuge
  - Pressure filtration
Sludge conditioning
  - Heat treatment
  - Chemical addition
Incineration
Land disposal
  - Liquid
  - Dewatered
Transport
  - Pipe
  - Truck

Miscellaneous facilities

Odor control
  - Chemical
  - Activated Carbon
  - Organic removal tower
Garage/shop bldgs.
Administration bldgs.
Site configuration
  - Facility locations
  - Roads
  - Landscape
Construction Methods/Materials
Control Systems
  - Computer
  - Analog
  - Manual
Electrical systems
HVAC
Yard piping
Fencing
Site lighting

The scope of the VE studies did not show any consistent pattern related to project size or complexity. The majority of the VE projects consisted of only a single workshop with a single team. Many projects had two workshops and relatively few projects were subjected to three or more workshops. In general, multiple teams were provided by large design firms and single teams by small firms.

The timing of the workshops is a critical element of a successful program, especially for projects with a single workshop. The early workshops offer the greater potential for savings even though details of construction or equipment selection cannot be evaluated at this stage. The later workshops offer lower potentials for savings because recommended changes are of smaller magnitude since the study emphasis is on process equipment and constructability of the project. A majority of the VE reports evaluated were held early in the design stage as shown in more detail in Table 4.

TABLE 4. DISTRIBUTION AND STAGE OF DESIGN COMPLETION OF WORKSHOPS

EPA Region	Number of projects evaluated	Number of workshops held	Stage of design completion of workshop				
			<20%	20-40%	40-60%	60-80%	80-100%
1	6	10	0	5	4	1	-
2	5	6	2	-	3	-	1
3	4	5	-	4	-	1	-
4	17	17	1	8	6	2	-
5	14	17	2	10	3	2	-
6	2	2	-	1	1	-	-
7	3	3	-	3	-	-	-
8	2	3	-	2	1	-	-
9	17	22	2	12	7	1	-
10	5	8	1	2	1	3	1
Total	75	93	8	47	26	10	2
Percent	-	-	8.6	50.5	28.0	10.8	2.1

CRITERIA USED FOR SELECTION OF VE RECOMMENDATIONS

The enormous number of individual recommendations from 75 VE projects required a selection system to reduce the number of ideas to a manageable level. The criteria used in the selection systeme are listed below:

- Estimated savings - Initial and life cycle costs
- Reliability
- Widespread applicability
- Technical validity
- Minimization of overlap between projects (same idea not evaluated for more than one project)
- A minimum of 1 idea from electrical and architectural disciplines per VE contract (where possible)

Only the first and last criteria represent an absolute selection. The latter item was included in order to include at least a certain number of ideas in areas where the savings have been small in terms of absolute dollars, at least relative to the potential savings associated with equipment or concrete changes. The other criteria were included to eliminate "one-of-a-kind" recommendations that may have saved a great amount of money on one project but which are not widely applicable. These criteria were an aid to selecting the best 10 to 15 ideas (if possible) from each workshop out of a total in the range of 5 to 60 ideas. In the first instance, as few as 1 or 2 have been included, but in the latter instance maybe as many as 20 were included. The intent was to present a representative sampling of ideas from each VE project, yet not to present the same idea more than once.

RECOMMENDATIONS ON CONDUCTING VE STUDIES

The VE reports examined for this publication clearly demonstrated that many positive benefits can be achieved from the use of VE studies. VE serves as a mechanism to enhance the design of wastewater treatment facilities by providing the project designer with an opportunity to utilize the knowledge and experience of other individuals to optimize the project design.

The review of the VE reports, as well as interviews and discussions with various EPA Regional VE Coordinators, State personnel, and firms experienced in conducting VE studies, formed the basis for the following recommendations. Appendix A of this publication contains detailed discussions of the data used to formulate some of thes recommendations.

- VE teams should closely follow the format for VE reports presented in the EPA Manual on "Case Studies and Formats", MCD 27. Such standardization of the VE reports will facilitate review and approval of the reports.

- The number of firms represented on a VE team should be minimized to improve the team's productivity. VE teams that include more than one consultant firm tend to be less creative than VE teams from a single firm.

- It is advantageous to the designer and owner not to use individuals from the designer's firm on the VE team, since VE teams not related to the designer's firm provide greater originality, creativity, and opportunity for cost savings. However, in the instances where the team must use personnel from the designer's firm, the team coordinator and at least two other members should be from another firm.

- VE teams should recommend only those ideas that they would implement on their own designs. This approach would eliminate the tendency to recommend unproven ideas.

- Each VE recommendation should include only a single idea. Several ideas in a recommendation may result in many good ideas being discarded due to the rejection of one idea in the recommendation.

- The VE teams should spend sufficient time on each recommendation to carefully and thoroughly develop it. The recommendations should include all assumptions and computations for capital, operating, and maintenance costs. Each recommendation should be clearly and concisely presented in the VE report.

- VE team members should have attended a 40 hour VE training workshop. However, this training should not be a rigid prerequisite for team membership since the success of a VE study is ultimately dependent on the pertinent experience of individual team members.

- VE teams should include at least two sanitary engineers since this engineering discipline normally has principal control of over 70 percent of the construction costs of a project. Two sanitary engineering team members will enhance the opportunity for interaction and creativity during the VE study.

- If only one VE study is scheduled for a project, it should be conducted during the 20 to 30 percent design stage to obtain maximum benefits from the study.

CHAPTER 2

BASINS AND TANKS

SHAPE

Replace Circular Final Clarifiers with Rectangular Clarifiers

The original concept proposed three 100-foot diameter final clarifiers, with a fourth clarifier to be added in the future. The sludge collection equipment was center column support, rapid removal type.

The proposed concept would use rectangular final clarifiers with traveling bridge suction sludge collectors. The tanks would be constructed with a common wall to the aeration tanks and contain channels for influent distribution, sludge collection, and effluent channels.

Fewer Passes in Chlorine Contact Chamber

A baffled chlorine contact tank was designed with four baffles, which produced five passes through the tank. The thickness of the interior baffling walls was the same as the exterior walls of the contact tank.

Use of three passes was recommended which eliminated two of the baffling walls. The thickness of the baffling walls was also reduced.

Reduce Depth of Equalization Basin

A flow equalization basin was designed with a depth of 25 feet.

Because of difficult subsurface conditions, a shallower depth basin with an equivalent volume resulted in a lower initial cost. A basin with a depth of 16 feet was recommended.

Change Aeration Basin Side Walls from Wye Wall to Tee Wall

Originally, the aeration basin side walls were designed with a wye configuration at the top, and with the main air header located in the wye. Aluminum access plates were used over the Wye opening.

The proposed concept used tee walls, with the main air header hung under the head of the tee on one side. This main header supplied air for the basins on each side of the wall. Sketches of the original and proposed concepts are shown in Figure 1.

Rearrange Basins to Reduce Length of Dividing Wall

The original design of the flow equalization basins involved the use of four separate, parallel basins. Each basin had separate feed and withdrawal piping. The walls were sheet pile dividers with walkways on top.

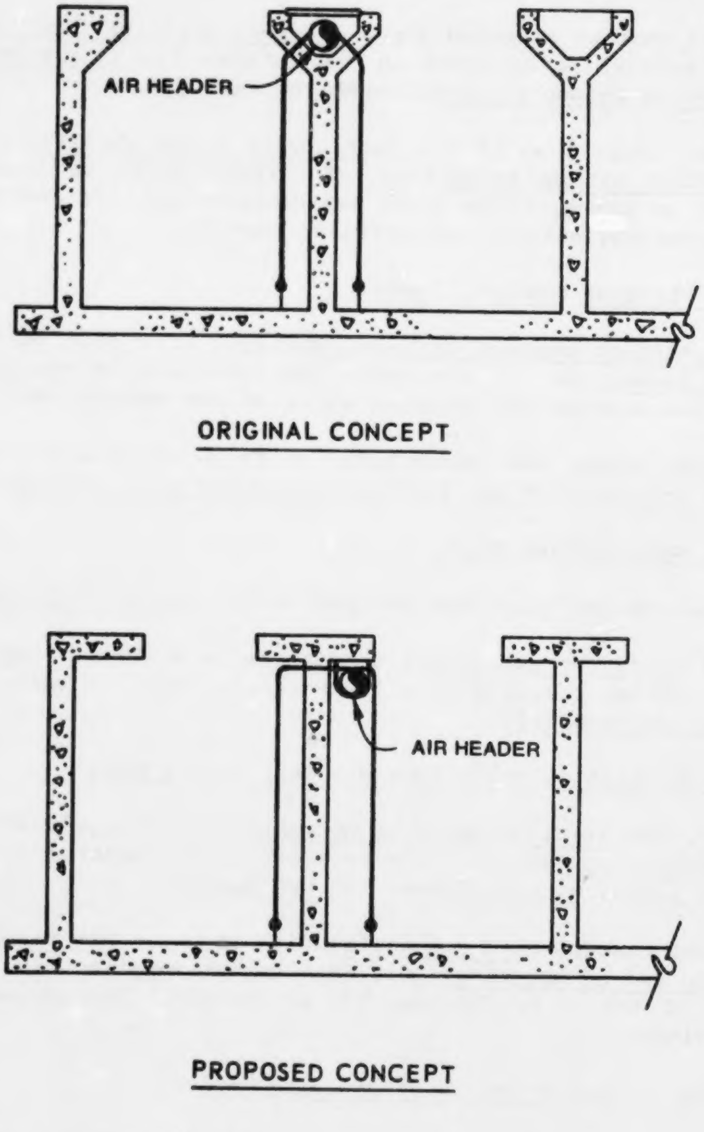

AIR HEADER
ORIGINAL CONCEPT
AIR HEADER
PROPOSED CONCEPT

Figure 1. Change wye wall to tee wall.

The proposed concept recommended that the four basins be arranged into a square configuration using sheet pile walls. The basin would intersect in the center of the square shape where a distribution structure would distribute and collect the flow and also house the sump pumps. Vehicular access to this point would be accomplished by using a dike substituting for one sheet pile wall and protruding to the center of the basin. The recommendation also eliminated 1000 feet of sheet pile from the original design. Original and proposed concepts are shown in Figure 2.

Change Circular Clarifiers to Square Clarifiers

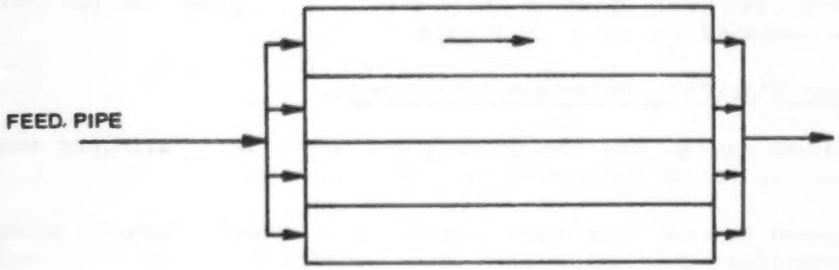
The original design for the primary and secondary clarifiers was circular with circular sludge collection mechanisms.

The proposed concept used square shaped basins with circular sludge collection mechanisms. The basins were constructed with common wall construction, also allowing equipment and pipe galleries for easier access for operation and maintenance. Sketches of the original and proposed system are shown in Figure 3.

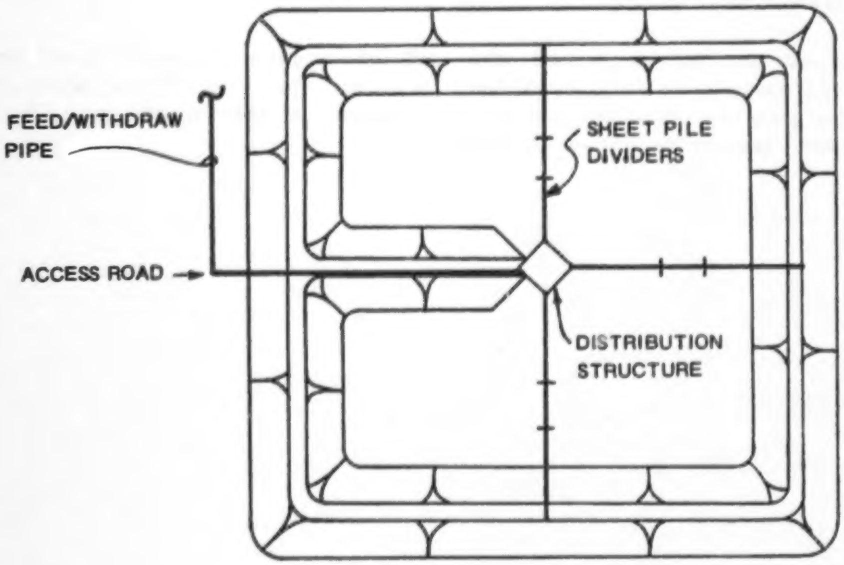
Change Rectangular Clarifiers to Square Clarifiers

The initial design included rectangular primary clarifiers with flight and chain sludge collection mechanisms. Scum removal was by low pressure air through directional headers.

The proposed design suggested the use of square primary clarifiers with common wall construction. A gallery between the clarifiers doubles as the raw sludge pumping station and a pipe chase. A sketch of the original and the proposed design is shown in Figure 4.

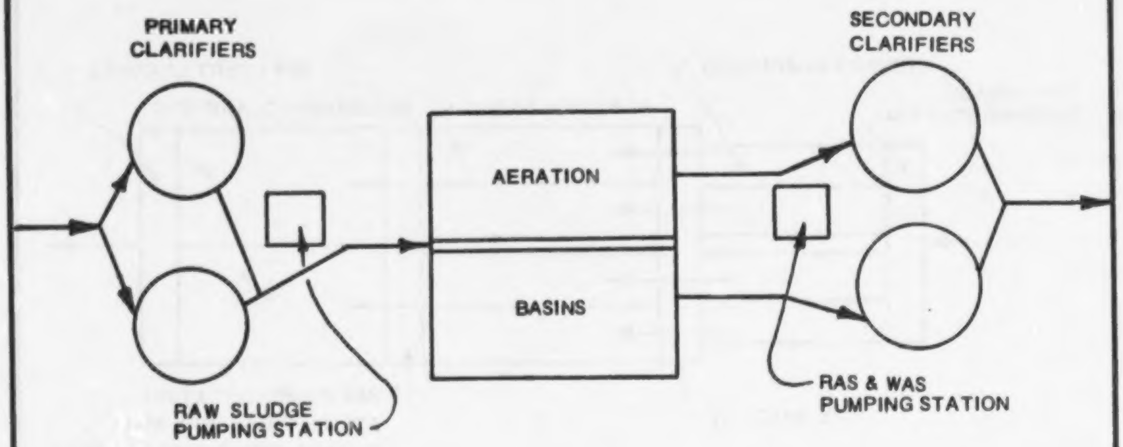


ORIGINAL CONCEPT

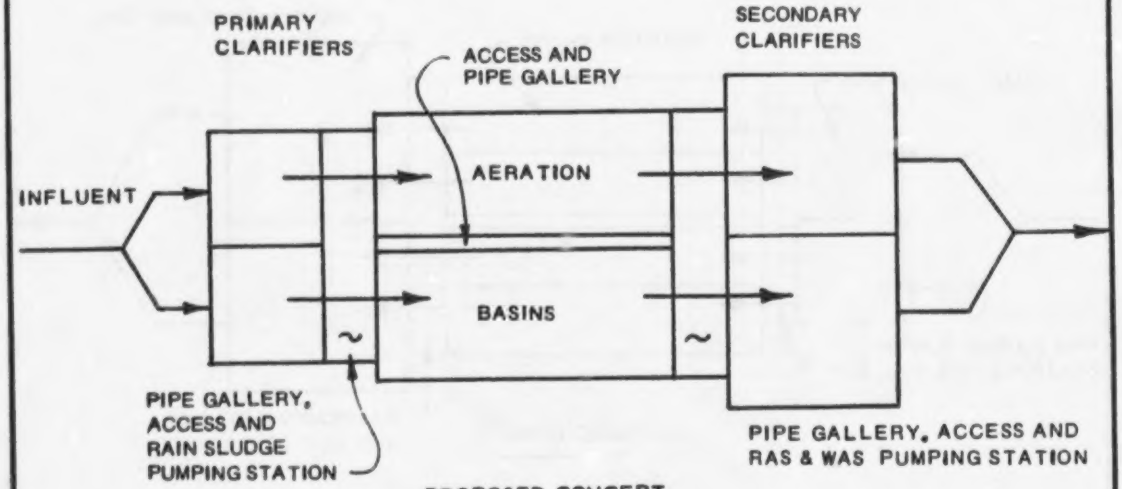

FEED/WITHDRAW
PIPE
SHEET PILE
DIVIDERS
ACCESS ROAD
DISTRIBUTION
STRUCTURE

PROPOSED CONCEPT

Figure 2. Reduce length of dividing walls.


PRIMARY
CLARIFIERS
AERATION
BASINS
SECONDARY
CLARIFIERS
RAW SLUDGE
PUMPING STATION
RAS & WAS
PUMPING STATION

ORIGINAL CONCEPT


PRIMARY
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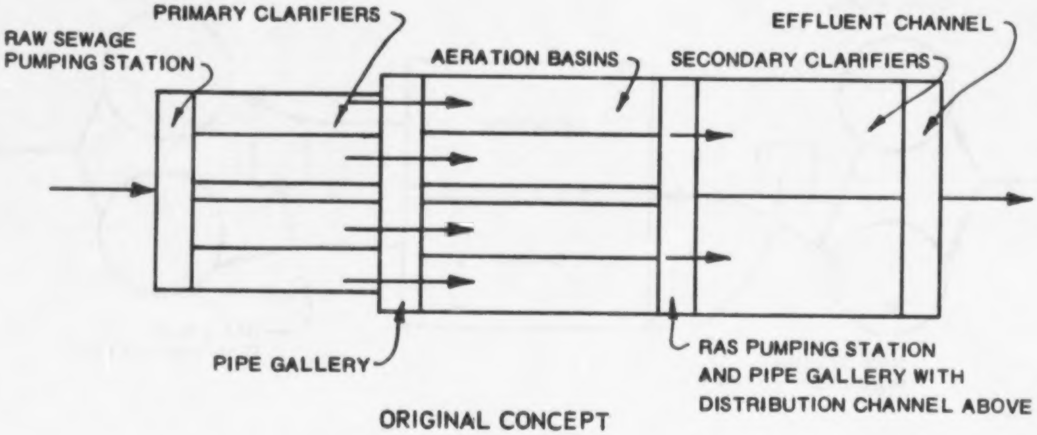
PROPOSED CONCEPT

Figure 3. Square clarifiers instead of circular.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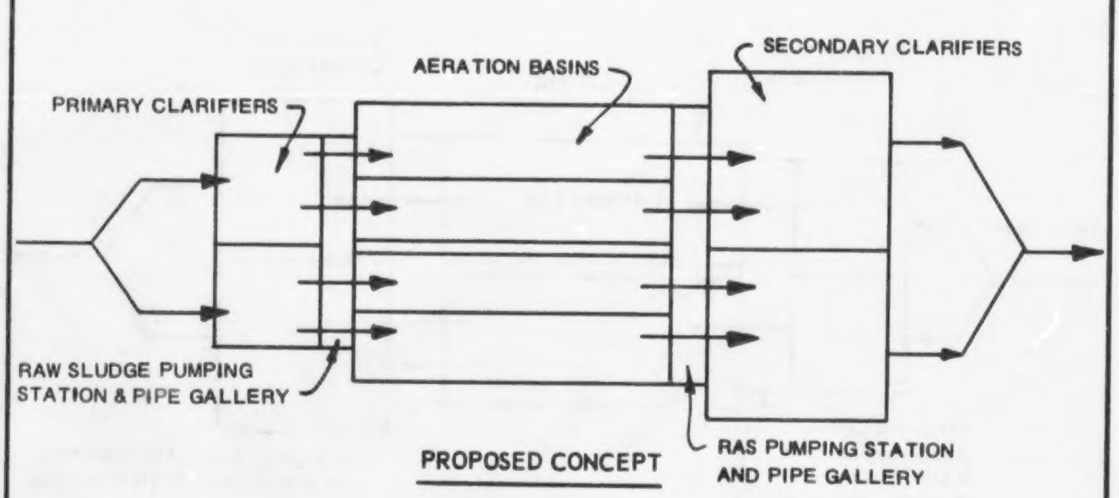
ORIGINAL CONCEPT


AERATION BASINS
SECONDARY CLARIFIERS
PRIMARY CLARIFIERS
RAW SLUDGE PUMPING STATION & PIPE GALLERY
RAS PUMPING STATION AND PIPE GALLERY

PROPOSED CONCEPT

Figure 4. Square clarifiers instead of rectangular.

SIZE

Reduce the Diameter and Depth of Primary Clarifiers

The original design concept used three 130' diameter circular clarifiers. Clarifiers were center fed, center well units with two scraper arms and each was equipped with a scum skimmer. The surface loading rate for the original clarifiers was 577 gpd/ft^2.

In the proposed concept the surface overflow rate would increase to 800 gpd/ft^2, which would reduce the clarifier diameter from 130' to 117' and the depth from 12' to 10'.

Reduce the Number of Intermediate Clarifiers

The original concept specified use of four circular 140' diameter center well clarifiers.

In the proposed concept, the original surface loading rate and solids loading rate would be retained, but the number of clarifiers would be reduced to three by increasing the clarifier diameter from 140' to 162'.

Reduce Final Clarifier Depth

In the original concept the sidewater depth of the final clarifiers was 12 feet. Sludge was to be removed using rapid sludge removal equipment.

The proposed concept decreased the final clarifier depth by two feet. With the rapid sludge removal equipment in the tanks, the sidewater depth could be reduced to 10 feet without loss of removal efficiency.

Enlarge the Clarifiers to Eliminate Need for Filters

The original design proposed construction of four 100 foot diameter clarifiers followed by effluent filters for additional suspended solids removal.

The proposed concept recommended constructing rectangular clarifiers with an overall 32% increase in the volume. This increase would be sufficient to improve suspended solids removal to a level which would eliminate the need for effluent filtration.

MATERIALS

Replace Structural Steel Framework with Precast Concrete TEE Sections

Three large diameter trickling filters were to be constructed with an outer structural wall consisting of corrugated steel sheets supported by a cor-ten steel framework.

It was proposed that prestressed concrete TEE sections be utilized as a substitute wall material. To assure a waterproof seal, a membrane liner was proposed.

Change Material for Sluice Gates

Originally, sluice gates were designed to be constructed from cast iron, with either bronze or stainless steel trim.

Heavy duty aluminum sluice gates trimmed with polyethelene were proposed. Stainless steel stems with crank operation were also recommended.

Change Basin Liner from Permeable Asphalt to Gunnite

Flow equalization basins were to be constructed using an earth structure concept with a permeable asphalt coating. This method of construction required an expensive sub-base, which was planned to consist of a 4" AC pavement on a 20" aggregate base.

The proposed concept recommended using reinforced gunnite in place of the asphalt liner. The recommended plan involved the use of 3" thick gunnite application with 4" by 4" wire mesh and a 4" thick aggregate base. Although the gunnite would not be able to withstand vehicular traffic, vehicular access to the bottom of the basin was not considered necessary in this case.

DESIGN CONCEPTS

Use Cover Over Grit Channel to Replace Handrails

Aluminum handrails were planned for use around grit removal channels.

Use of fiberglass panels over the grit channels were recommended instead of handrails. According to OSHA requirements, if such covers are used, they must be in the down position at all times unless they are attended.

Eliminate Center Walkways

In the original design, each aeration basin center wall was equipped with a walkway and spray nozzles for foam control.

It was recommended that the walkway, spray header, and nozzles be eliminated from the center or intermediate walls.

Construct 3 Circular Secondary Clarifiers Instead of 4

The plant to be constructed utilized two-stage biological treatment, modified aeration activated sludge for the first stage and suspended growth nitrification for the 2nd stage. Rectangular intermediate clarifiers were used after the 1st stage, and 4-115' diameter clarifiers were recommended after the 2nd stage nitrification.

The proposed concept recommended the construction of 3-160' diameter clarifiers. This change would result in approximately the same overflow rate, but the cost would be considerably less for 3 clarifiers than for 4 clarifiers. Although higher overflow rates would occur with one clarifier out of service, this was judged to be acceptable because effluent storage lagoons were available for use in emergency conditions.

Above Grade Storage for Backwash and Pumped Backwash

The original design of the filtration system included provisions for backwashing the filters using gravity flow, and then collecting the backwash water in a sump under the filter control building.

The proposed concept recommendated using pumped backwash from an at-grade storage tank. This alternative allowed the filters and the underground backwash water sump to be raised to ground level.

Use the Interceptor Volume as Part of the Flow Equalization Basin Storage

The original concept called for a major flow equalization basin structure to retain stormwater flows to the treatment plant. Flow was to be diverted from the interceptor to this structure when the treatment capacity of the plant was exceeded.

The proposed concept recommended using storage capacity in the interceptor tributary to the plant, with a resultant reduction in the required capacity of the flow equalization basin.

Combine Chlorine Contact With Post Aeration

The original design provided separate chlorination basin, cascade aeration and post aeration tank followed by dechlorination (SO_2) and pH adjustment (NaOH).

The proposed alternative eliminated the intermediate cascade aerator. The size of the chlorination tank remained the same, although the post aeration tank required enlargement. Common wall construction between the chlorination basin and the post aeration tank was proposed. The larger post aeration tank provided increased contact time, increased post aeration and reduced SO_2 and NaOH requirements. Figure 5 shows sketches of the original and proposed concepts.

Use Outfall as Chlorine Contact Basin

A chlorine contact chamber was included in the original plant design prior to the outfall.

Elimination of the chlorine contact chamber was proposed, with the required chlorine contact time being accomplished in the outfall. This concept was feasible because the outfall provided an overall detention time which exceeded the detention time in the planned chlorine contact chamber.

Simplify Chlorine Contact Chamber Valving

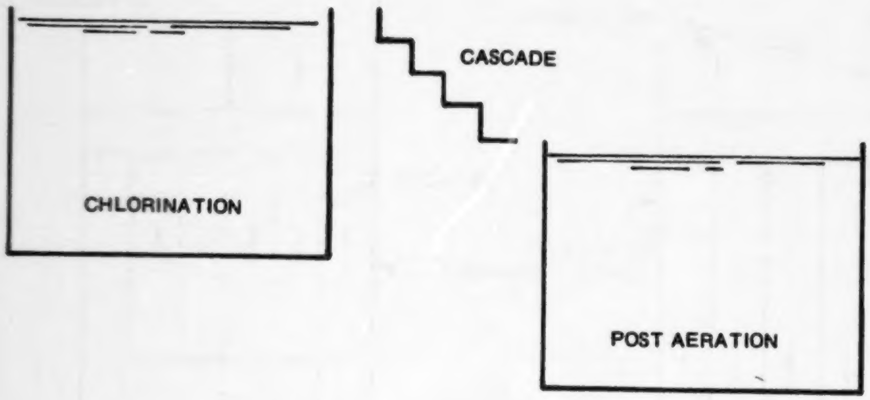
A chlorine contact chamber was designed to operate using serpentine flow through five channels. Each channel was designed with the capability of being fully isolated from the other channels, which would allow any channel to be taken out of service for cleaning.

Division of the chlorine contact chamber into 2 separate compartments, each with a five pass serpentine flow was proposed. This approach would allow either half of the contact chamber to be taken out of service, without disturbing the other half. Redwood dividers were proposed for baffling, instead of the concrete baffle walls in the original design. Sketches of the original and proposed concepts are shown in Figure 6.

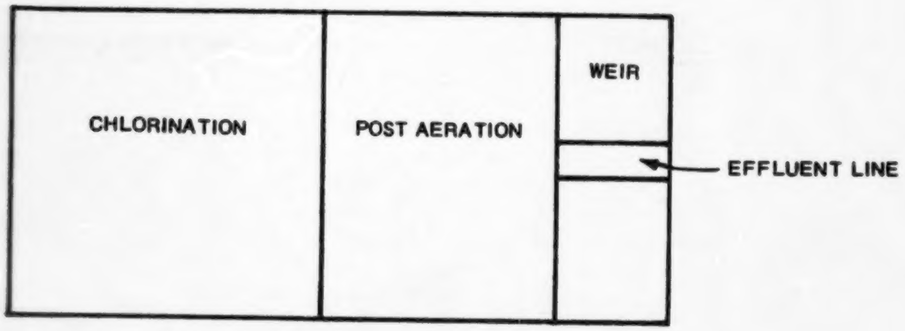
Eliminate Inboard Launder on Secondary Clarifier

The initial design concept utilized 80' diameter clarifiers with a double inboard launder.

The proposed concept recommended eliminating the inboard launders and using outboard launders. Sketches of the proposed and original concepts are shown in Figure 7.


CASCADE
CHLORINATION
POST AERATION

ORIGINAL CONCEPT


WEIR
CHLORINATION
POST AERATION
EFFLUENT LINE

PROPOSED CONCEPT

Figure 5. Common wall construction between chlorination and post aeration.

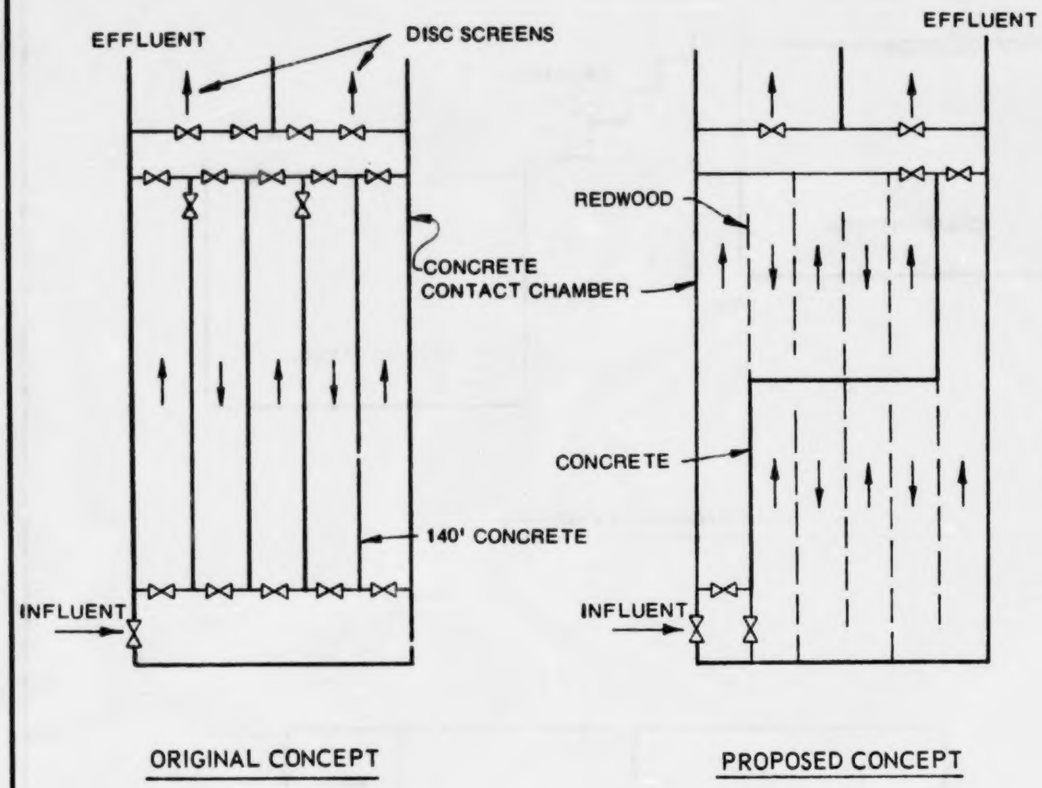
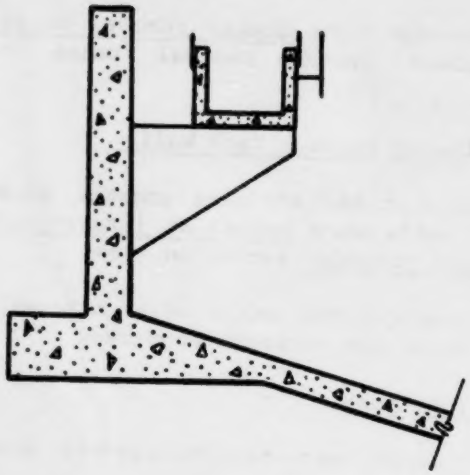
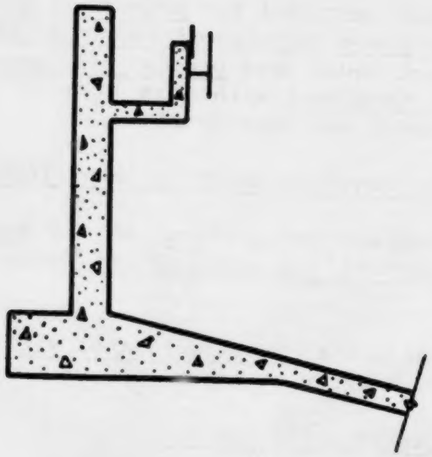

EFFLUENT
DISC SCREENS
CONCRETE
CONTACT CHAMBER
140' CONCRETE
INFLUENT
ORIGINAL CONCEPT
EFFLUENT
REDWOOD
CONCRETE
INFLUENT
PROPOSED CONCEPT

Figure 6. Simplify chlorine contact tank valving.



ORIGINAL CONCEPT



PROPOSED CONCEPT

Figure 7. Use outboard launders.

Delete Headworks Grease Removal

In the original concept, grease removal was provided in a separate basin located between the grit chamber and the primary clarifier. Also, grease skimmers were included on the primary clarifiers.

In the proposed concept, the grease removal basin was eliminated, thereby having the complete grease removal being accomplished at primary clarification.

Reduce Thickness of Effluent Storage Tank Walls

In the original concept the effluent storage tanks had interior walls 18-inches thick. The walls were braced at intermediate points by baffle walls or had no unbalanced pressure acting on them.

In the proposed concept the walls were reduced to 12-inches thick thus reducing the volume of the concrete required.

Reduce Clarifier Slab Thickness

In the original concept, secondary clarifiers were designed with a 30-inch slab thickness.

In the proposed concept, the slab thickness was reduced to 20-inch.

Use Precast Circular Tank Walls

The original concept provided two primary clarifiers and three final tanks which had cast-in-place reinforced concrete walls and effluent launders. The proposed concept would used precast wall panels either grouted or bolted together and post tensioned with wire strands on the outside covered with shotcrete. The launder was cast-in-place.

Use Concrete Channel for Aeration Basin Influent Instead of Pipe

In the original concept the influent to the aeration tanks was distributed by means of a concrete box with sluice gates and 30-inch pipe for each unit.

In the proposed concept a concrete channel with stop plates would distribute the influent to each aeration tank.

Redesign Anaerobic Digester Walls and Mat

The original design proposed a 34-inch thick digester wall which consisted of 28-inch of reinforced concrete, a 2-inch air space, and a 4-inch brick layer.

The proposed design was for a 22-inch thick wall consisting of 16-inch of reinforced concrete and 6-inch of insulation. The reduction in digester wall thickness was accomplished using tension rings. A parapet was also eliminated from the top of the digester wall, and the digester slab was redesigned to reduce concrete and reinforcing steel. Overall, an approximate 1/3 savings in concrete and reinforcing steel was accomplished.

Use Single Precast Scum Box

The original design used a separate cast in place scum box for each of two primary clarifiers.

The proposed concept recommended combining the two scum boxes into a single, precast unit, thereby lowering the construction cost and reducing the number of control valves required.

Tilt up Baffle Walls in Chlorine Contact Tank

The original concept used conventional 12-inch thick reinforced concrete walls as baffles in the chlorine contact basin.

The proposed concept reduced installation time by using tilt up baffle walls. The walls, struts and beams would be cast on the completed floor slab, set up in place, and welded at the base. Beams and struts would be placed and tack welded.

Reduce Effluent Wall Thickness

The original concept utilized concrete channels for collection of the final clarifier effluent. The walls of the channels were 12-inch thick.

The proposed concept would reduce the thickness of the effluent channels to 8-inch.

Use all Steel Effluent Troughs in Place of Concrete and Steel Troughs

The original concept proposed to use an outboard concrete trough for a circular clarifier as well as an inboard steel effluent trough.

The proposed concept would use larger diameter steel effluent troughs and eliminate the exterior concrete troughs.

Eliminate Cover on Aerobic Digesters

The original concept included covering the existing primary clarifiers and aerobic digesters. Gas under the covers was to be collected and cleaned for odor control purposes.

In the proposed concept the existing primary clarifiers and aerobic digesters would be utilized without covers since odor control was not a problem in the existing facility.

Omit Preareation Basin--Use Preaeration Channels

In the original concept, a preaeration tank was located between the grit tank and the primary clarifier. The tank utilized mechanical aerators which were covered to capture and scrub the air for odor control. The primary clarifiers also had air collection and treatment facilities for odor control.

In the proposed concept, the preaeration basin were eliminated and replaced with an aerated channel. The channel would have a fiberglass cover, but the air would not be treated for odor control.

Reduce Depth of Slab for Flow Equalization Basin

In the original concept a rectangular flow equalization basin was designed with a 1.5 ft thick floor.

In the proposed concept, the thickness at the center of the slab was reduced to 0.5 ft. The perimeter footing retained the 1.5 ft thickness.

CHAPTER 3

PROCESS EQUIPMENT

FLOW EQUALIZATION

Eliminate Flow Equalization Basin

Initially, flow equalization basins were provided to dampen flow peaks influent to a plant.

The proposed concept suggested using variable frequency type pumps with variable speed drives to limit the flow peaks, eliminating the need for flow equalization basins.

Eliminate Blending Basin

Flow arrived at the plant through force mains from a series of remote pumping stations. A blending basin was included in the original design to homogenize the quality of wastewater from the different force mains. Air diffusion was used in the blending basin to mix the basin contents.

Elimination of the blending basin was proposed, since sufficient blending would occur in the grit removal basin and the primary clarifier.

Use Interceptor Storage Capabilities

To equalize wet weather and other peak flows through a plant, an influent storage basin was proposed. The storage basin would be located on-site, before the raw wastewater pumping facilities.

An analysis of the 72-inch influent sewer indicated that it contained over 3.5 mgd of usable storage capacity at peak flows, which was more than the proposed capacity of the influent storage basin. It was proposed to use the storage capacity of the interceptor and eliminate the proposed storage basins. Coincidentally, because the storage capacity of the interceptor was greater than the proposed storage basins, the required capacity of the raw wastewater pumping facilities was also reduced.

Substitute Swirl Concentrator for Flow Equalization Basin

The original concept provided for flow equalization by use of a covered three cell basin, with sludge collection equipment. The basin had a capacity of 5.5 million gallons. Coagulants were planned to be added to the equalization basin.

The proposal was to use a swirl concentrator in lieu of the flow equalization basin. Flows in excess of plant hydraulic capacity were to be settled to remove solids, disinfected, and discharged through a chlorination basin.

Remove Sludge Collection System from the Flow Equalization Basin

In the original concept a covered three cell basin with sludge collection equipment was provided for flow equalization. Traveling bridge sludge collection mechanisms were to be provided to collect and remove the sludge.

The proposed concept recommended flow equalization basins without sludge removal equipment. The sludge would be removed manually.

Eliminate Flow Equalization Basin

Flow equalization basins were provided at the treatment plant to dampen flow peaks which were caused by several large package lift stations.

The proposed change was to use a throttling valve at the lift station to limit flow peaks, and thereby eliminate the need for the flow equalization basins.

Use Concrete Lined Earthen Basin

The original design included concrete flow equalization basins with submerged turbine aerators for aeration and mixing.

The use of concrete lined earthen basins of the same volume was proposed. Because the project was upgrading an existing plant, it was recommended that the static tubes from existing aerated lagoons to be salvaged and used with a new blower to insure adequate mixing. The proposed and original designs are shown in Figure 8.

Pumped Mixing Instead of Jet Aeration Mixing

Originally the flow equalization basin used a jet aeration mixing system.

The proposed concept recommended using pumped mixing to replace the jet aeration system.

Eliminate Flow Equalization Basin

In the initial concept flow equalization was provided by a covered three-cell basin with collection equipment provided to remove the sludge. The basin was intended to be used during wet weather flow in excess of the design flow rate. If overflows occurred during a storm, they would discharge to the plant effluent after receiving chemical aids for coagulation and disinfection. Raw wastewater remaining after the storm would be treated in the plant after influent flow dropped below the plant design flow. The basin was covered and ventilated air from the basin would be treated by chemical scrubbing.

In the proposed concept, the flow equalization basin would be completly removed and influent in excess of plant design would be chlorinated and discharged.

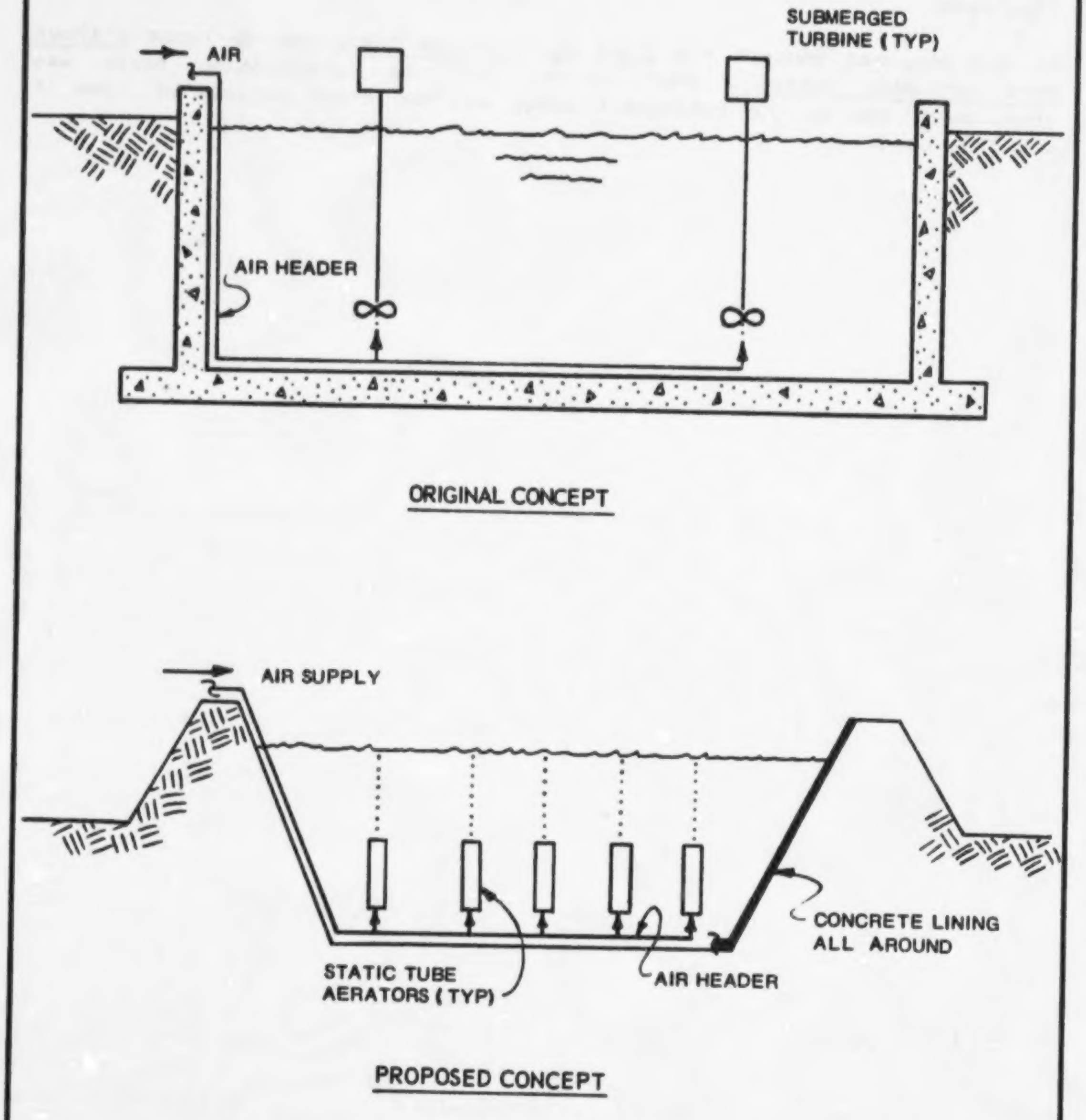

AIR
SUBMERGED TURBINE (TYP)
AIR HEADER
ORIGINAL CONCEPT
AIR SUPPLY
CONCRETE LINING ALL AROUND
STATIC TUBE AERATORS (TYP)
AIR HEADER
PROPOSED CONCEPT

Figure 8. Substitute earthen basin for concrete basin.

Eliminate Flow Equalization Basin Cover

In the original concept a covered three-cell basin with sludge collection equipment was provided to receive wet weather flows in excess of the design flow rate.

In the proposed concept the flow equalization basin was designed without roof or odor control. Odor control for the equalization basin was unnecessary due to the infrequent usage and the short periods of time it would be used.

PUMPS - INFLUENT AND EFFLUENT

Revise Inlet Direction into Pumping Station

A large effluent pumping station used a rectangular wet well and five pumps. The wet well was arranged in a manner which required flow to make a 90° change in direction before reaching the pumps.

A re-arrangement of the wet well was proposed which would equalize the flow to each of the pumps and eliminate potential dead spots in the wet well. The re-arrangement was based upon Hydraulic Institue Standards for wet wells, and eliminated the 90° change in direction in the original design. Figure 9 shows sketches of the original and proposed concepts.

Delete Redundant Wet Well Dewatering Systems

A large interceptor pumping station was designed to handle separate wet weather flows and dry weather flows. The pumping station was designed as two separate pumping stations in one structure. Separate wet wells, pumps, and discharge piping were provided for wet weather and dry weather flows. Provision was made for separate dewatering systems for the wet weather pump sump and dry weather pump sump when systems pumps were not in operation or were down for repairs.

Use of a single sump dewatering system for both the wet weather and dry weather pumps was proposed, thereby eliminating one of the original dewatering systems.

Variable Speed and Constant Speed

The original design concept used four variable speed pumps in the raw sewage pump station. The pump station was planned to pump an equalized flow of 12.5 mgd.

The proposed change modified the system to utilize two constant speed and two variable speed drive pumps. The constant speed units would be sized to pump the average flow rate while the variable speed units would be used to pump the additional flows.

Right Angle Drive Instead of Horizontal Drive

The original concept proposed five gas engine drives for the influent pump station. The pumps and gas engines were both located below grade in the dry well, thereby allowing horizontal drive between the engines and pumps.

The proposed concept recommended the installation of the gas engines at grade, with a right angle gearbox to transmit power to the pumps. The proposal significantly reduced the dry well size. Simplified sketches of the original and proposed designs are shown in Figure 10.

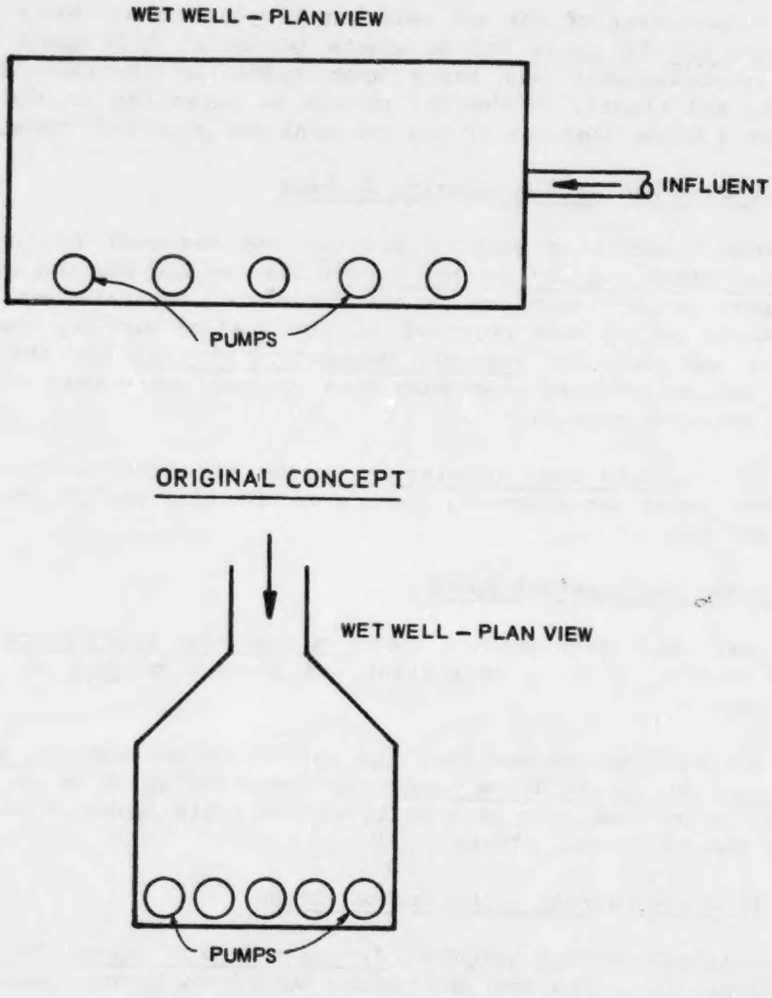
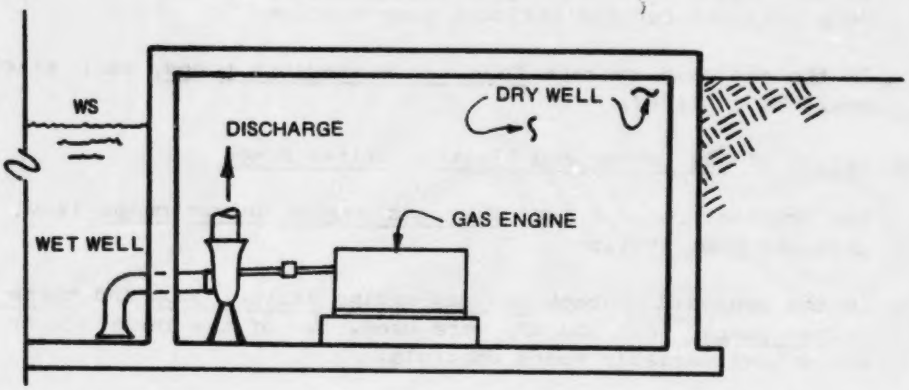
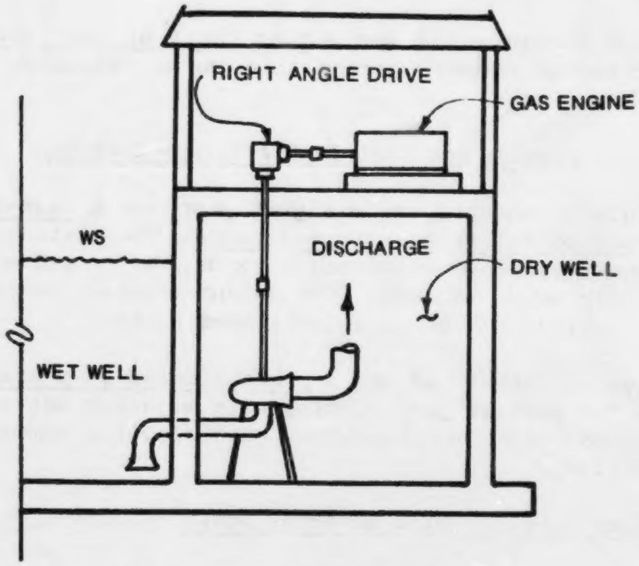

WET WELL – PLAN VIEW
INFLUENT
PUMPS
ORIGINAL CONCEPT
WET WELL – PLAN VIEW
PUMPS
PROPOSED CONCEPT

Figure 9. Revise inlet to pumping station.


WS
DISCHARGE
DRY WELL
GAS ENGINE
WET WELL

ORIGINAL CONCEPT


RIGHT ANGLE DRIVE
GAS ENGINE
WS
DISCHARGE
DRY WELL
WET WELL

PROPOSED CONCEPT

Figure 10. Right angle drive system.

Four Pumps in Place of Five

In the original concept five raw wastewater pumps, each sized at 7,900 gpm were proposed for the influent pump station.

In the proposed concept four raw wastewater pumps, each sized at 9,900 gpm would be utilized.

Combination of Gas Driven and Electric Driven Pumps

The original concept used five gas engine driven pumps (each 150 HP) in the influent pump station.

In the proposed concept two gas engine driven pumps and three electric motor driven pumps, each 150 HP, were used. Two of the three electric driven pumps would have variable speed controls.

Vertical Pumps in Place of Horizontal Pumps

The original concept proposed using a primary pump station with four horizontal constant speed pumps to pump 13 mgd average flow to the primary clarifiers. The horizontal pumps were located in a dry well with a superstructure constructed above the dry well to house the motor control center, air compressors, stairwell, and equipment hatches and overhead hoist.

The proposed concept would use either three or four vertical pumps in place of the horizontal pumps, thereby allowing a reduction in the dry well and building size.

Prefabricated Pump Station for Cast-In-Place Pump Station

In the original concept, the designer proposed a cast-in-place pump station with four horizontal constant speed pumps. The station capacity was 13 mgd. The horizontal pumps were located in a dry well, and a building was located above the dry well to house the motor control center, air compressors, stairwell, equipment hatches and overhead hoist.

The proposed concept would use a prefabricated pump station with four vertical pumps. The package pump station with adjacent wet well would contain all the pumps, controls, appurtenances, and elevator access to the below grade pumping facility.

Vertical Propeller Pumps in Lieu of Screw Pumps

The original concept proposes a secondary effluent pumping station using 72-inch diameter screw pumps each having a capacity of 17,000 gpm and a lift of 20 feet.

The proposed concept used vertical propeller pumps with a simplified but deeper wet well.

Switch Sizes of Variable Speed and Constant Speed Pumps

A raw wastewater pumping station was to be constructed with 120 mgd of pumping capacity. Two 40 mgd variable speed pumps were to be used in conjunction with two 20 mgd fixed speed pumps.

As a greater percentage of flow occured in the lower flow ranges, an overall increase in pumping station efficiency was proposed by the use of fixed speed pumps to handle the lower flows and variable speed pumps for the peaks. Two 40 mgd fixed speed pumps and two 20 mgd variable speed pumps were proposed.

Fixed Speed Pumps for Variable Speed Pumps

Four raw sewage influent pumps were called for, each designed as a variable speed unit.

Two variable speed and two constant speed pumps were proposed to eliminate the need for two 100 HP magnetic drive units.

Combine Separate Effluent and Storm Water Pump Stations into One Station

In the original concept there were two 60 mgd pumping stations, one for the plant effluent and one for a storm-water channel located on the plant site. Both stations pumped flow to an adjacent river and both had approximately the same discharge head.

It was proposed that these two pumping stations should be combined into a single structure, with use of the same pump (20 mgd) as the standby for both facilities. Aspects of the proposal were the use of common wall construction, a savings in electrical power distribution facilities, and an overall reduction in excavation.

Cooling Water Pumps for Diesels

A large effluent pumping station used two diesel engines to drive two pumping units. Cooling water for the diesels was provided by three (one standby) electrically-driven cooling water pumps. In the event of a power failure, the plant did have standby generation capability, which would be able to supply power to the electric motors driving the cooling water pumps.

The proposed concept recommended driving the cooling water pumps by a gear drive from the diesel units. One cooling water pump was proposed for each diesel, eliminating the standby pump in the original design. The three electric motors in the original design were also eliminated.

Substitute Screw Pumps for Vertical Propeller Pumps

Effluent pumping to a nearby river was planned to be by a 60 mgd pumping station which would use four 20 mgd vertical propeller pumps.

Screw pumps were **proposed** as a replacement, using 3 installed at 20 mgd each, with one 20 mgd standby pump.

PUMPS - PROCESS

Change Suction and Discharge Valving

An effluent pumping station was designed with manually operated gate valves on suction and discharge lines, and a 24-inch check valve on the discharge lines.

A proposal was made to substitute butterfly valves for the gate valves on the influent and effluent lines. Also, replacement of the check valves on the effluent lines with motor operated butterfly valves was proposed.

Vertical Turbine Pumps to Eliminate Dry Well

Effluent pumping was originally planned to be by use of centrifugal mixed flow pumps. Pumps were located in a dry well and drew suction from an adjacent wet well.

To eliminate the need for the dry well, vertical turbine pumps were proposed instead of the centrifugal mixed flow pumps. The vertical turbine pumps would be located directly above the wet well. The proposal eliminated the dry well and considerable amount of suction valving. Schematics of the proposed and original concepts are shown in Figure 11.

Add Influent Pumping and Eliminate Effluent Pumping

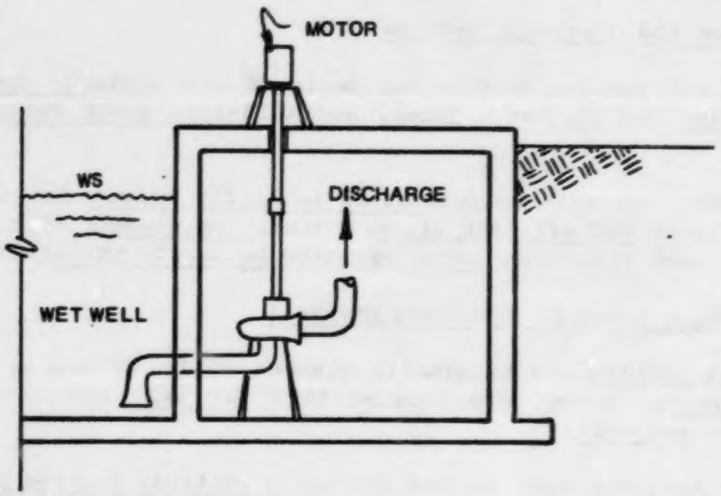
Influent wastewater flow to the plant was by two conduits, one a force main and the other a gravity interceptor, the latter carrying less than half the influent flow. Due to the plant layout and elevation, a portion of the available head in the force main was lost at the headworks. The plant layout required a low lift pumping station for the plant effluent.

The proposed concept recommended some minor plant layout changes which resulted in raising the headworks elevation and utilization of the head in the influent force main flow. This change also necessitated the addition of a screw pump to boost the flow from the gravity interceptor to the new headworks elevation. The proposed changes allowed gravity discharge from the plant, eliminating the need for an effluent pumping station.

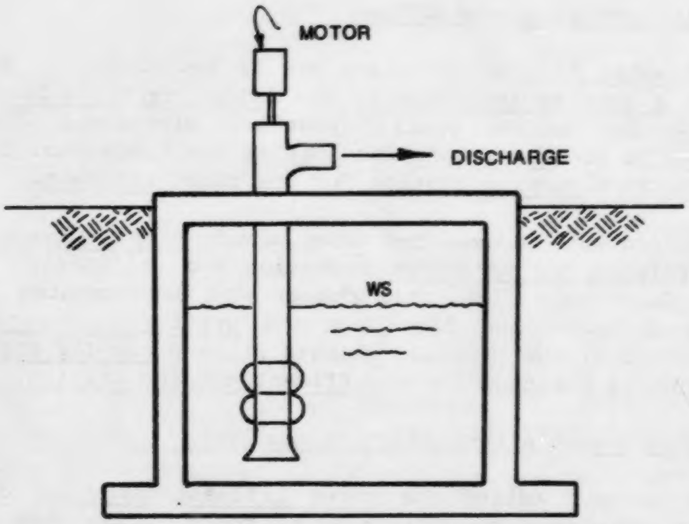
Smaller Influent Pumps with a Pump Added in the Future

The original concept called for three influent pumps of 33.6, 38.5, and 39.5 mgd. The pumps were to utilize wound rotor motors with liquid rheostat control.

The proposed concept suggested the initial installation of 3 pumps of 24 mgd each, and the addition of a forth 24 mgd pump 12 years in the future, when influent flows projection dictated such an addition. The proposed concept also included use of frequency change for motor speed control and the use of squirrel cage motors.


MOTOR
WS
DISCHARGE
WET WELL

ORIGINAL CONCEPT


MOTOR
DISCHARGE
WS

PROPOSED CONCEPT

Figure 11. Vertical turbine pumps.

Use Self-Priming Pumps

The original design for the sludge pumps used centrifugal pumps located in a dry pit. The design also included an upper level building above the pit.

The proposed concept recommended using self-priming pumps located at grade to eliminate the dry pit at the decant pump station. The recommended system eliminated the dry pit, reduced piping, and eliminated building and ventilating requirements.

Use Return Pumps for Wasting Sludge

In the original design, separate pumps were use for return and waste activated sludge.

The proposed concept recommended using the return pumps for both returning and wasting activated sludge.

Combine Primary Effluent and Biofilter Recirculation Pump Stations

In the original design, a pump station lifted primary effluent to the wet well of the biofilter pumping station. The biofilter pumping station pumped primary effluent plus biofilter recycle to the top of the biofilter.

The proposed concept recommended combining these two pump stations into a single station in order to provide a lower construction cost, fewer pumps and simpler operation. Sketches of the original and proposed concepts are shown in Figure 12.

Pump Directly to Biofilter

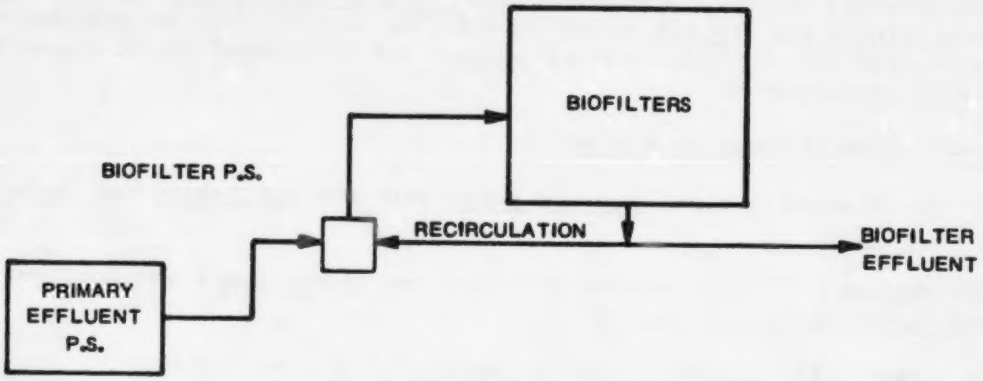
In the original design, the primary effluent pump station lifted primary effluent to the recirculation pump station which then pumped primary effluent and biofilter recirculation to the top of the biofilter.

The proposed concept recommended reduced the size of the recirculation pump station and increased efficient energy use when it recommended pumping primary effluent directly to the biofilter using the primary effluent pump station. The recirculation pump station would then be used only for biofilter recirculation to maintain the wetting rate on the media. Sketches of the original and proposed concepts are shown in Figure 13.

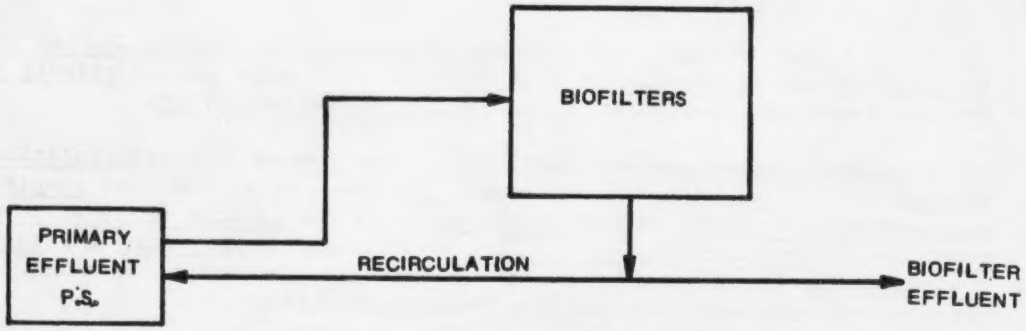
Use Positive Displacement Pumps at Air Flotation Thickeners

The original concept used recessed impeller pumps to pump air flotation thickened sludge from a wet well to subsequent dewatering.

The proposed concept recommended positive displacement pumps. It was noted that experience with the original pumps indicated that recessed impeller pumps would air lock when used in this application.

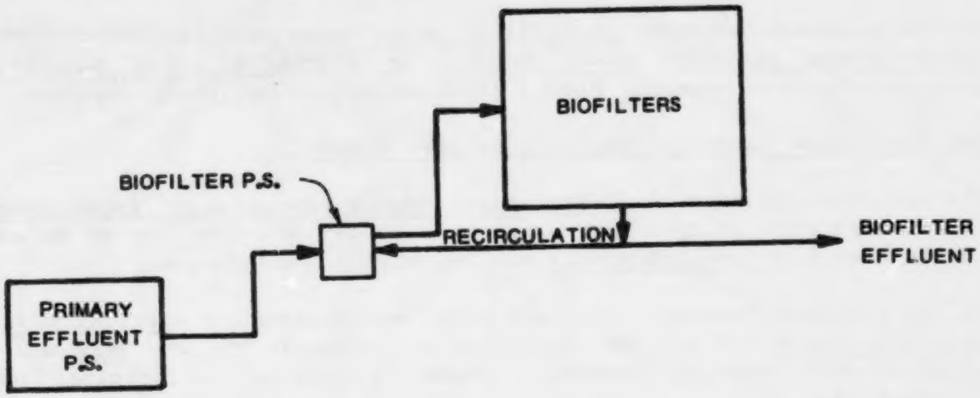

BIOFILTERS
BIOFILTER P.S.
RECIRCULATION
BIOFILTER EFFLUENT
PRIMARY EFFLUENT P.S.

ORIGINAL CONCEPT

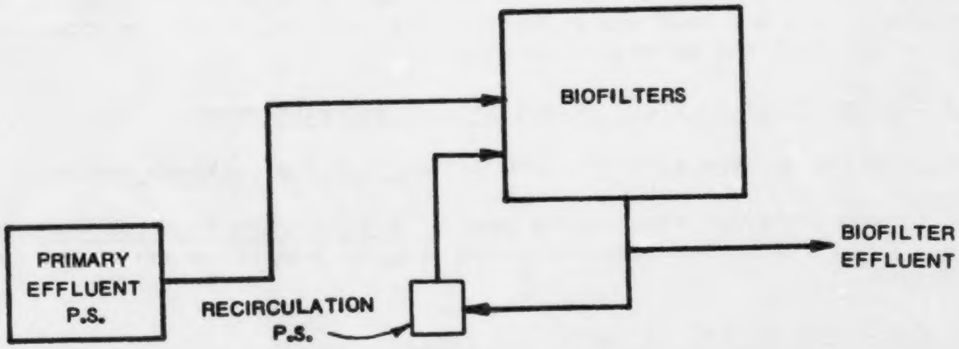

BIOFILTERS
PRIMARY EFFLUENT P.S.
RECIRCULATION
BIOFILTER EFFLUENT

PROPOSED CONCEPT

Figure 12. Combine pumping stations.


BIOFILTERS
BIOFILTER P.S.
RECIRCULATION
BIOFILTER EFFLUENT
PRIMARY EFFLUENT P.S.

ORIGINAL CONCEPT


BIOFILTERS
BIOFILTER EFFLUENT
PRIMARY EFFLUENT P.S.
RECIRCULATION P.S.

PROPOSED CONCEPT

Figure 13. Pump primary effluent directly to bio-filters.

Substitute Centrifugal Returned Activated Sludge Pumps for Screw Pumps

In the original concept, screw pumps were specified for return activated sludge pumping to a channel and hence to the aeration basin. Pump control was to be by either speed control or wet well level control.

In the proposed concept, centrifugal pumps were provided for return activated sludge pumping. Speed control or discharge valve throtting was proposed for rate control. Figure 14 shows before and after sketches.

Vertical Mixed Flow Pumps for Return Activated Sludge

The original concept used horizontal single stage centrifugal pumps for return activated sludge. Four pumps were to be used with one to be added in the future. A wet well/dry well pumping station was planned.

In the proposed concept, pump selection was changed to vertical mixed flow (wet pit) pumps and the building size was reduced. The dry well was eliminated in this concept. Figure 15 shows sketches of the original idea and proposed idea.

Use Variable Speed Vertical Mixed Flow Pumps for Filter Influent

The original concept called for four screw pumps to lift final effluent to the tertiary filters. The pumps were located at the tertiary filter building and the screws are exposed to the weather while drives and pump discharges were enclosed in a building.

The proposed concept used four vertical pumps driven by variable frequency drives. The pumps and drives were enclosed in a smaller building while a portion of the wet well was exposed to the weather. Figure 16 shows sketches of the original and proposed concepts.

Vertical Turbine Pumps in Place of End Suction Backwash Pumps

The original concept uses 3 - 7200 GPM end suction backwash pumps.

The proposed concept recommended using 2 - 10,000 GPM vertical turbine backwash pumps with separate backwash supply and backwash waste headers provided.

Use Vertical Pumps Instead of Horizontal Pumps

The original concept used horizontal centrifugal pumps for return of nitrified secondary effluent and nitrified return sludge. Pumping head was 21' TDH.

Use of vertical mixed flow pumps in the return sludge wet well was recommended to eliminate the dry well.

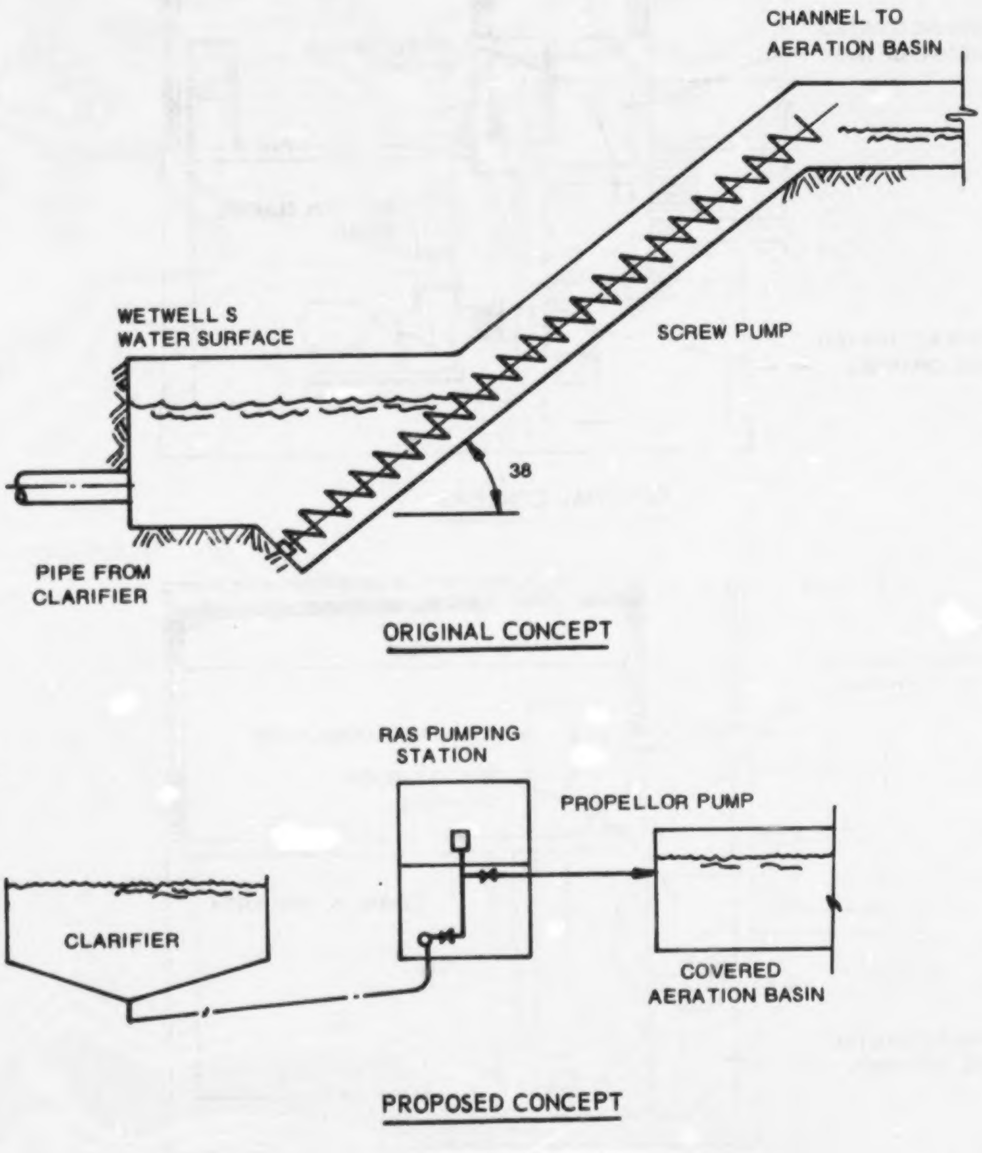

CHANNEL TO
AERATION BASIN
WETWELL S
WATER SURFACE
SCREW PUMP
38
PIPE FROM
CLARIFIER
ORIGINAL CONCEPT
RAS PUMPING
STATION
PROPELLOR PUMP
CLARIFIER
COVERED
AERATION BASIN
PROPOSED CONCEPT

Figure 14. Use mixed flow pumps in lieu of screw pumps.

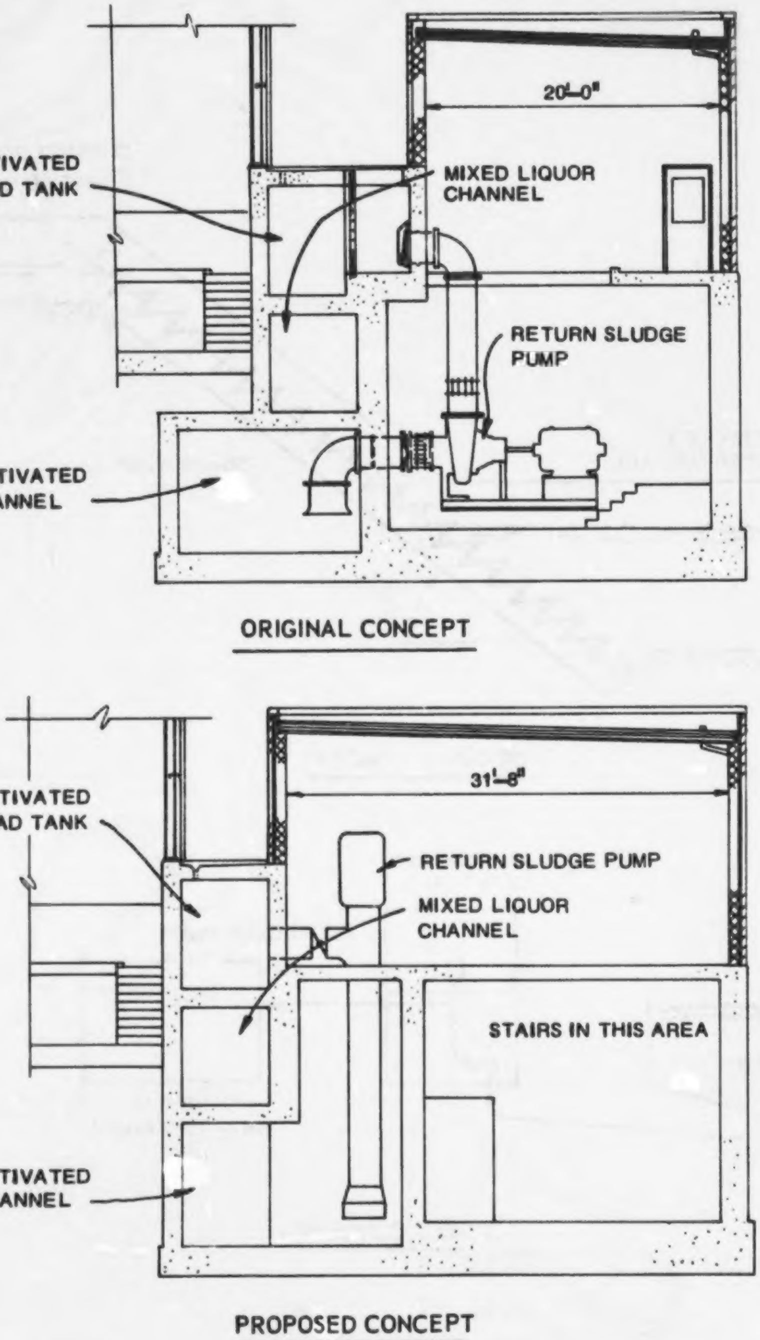
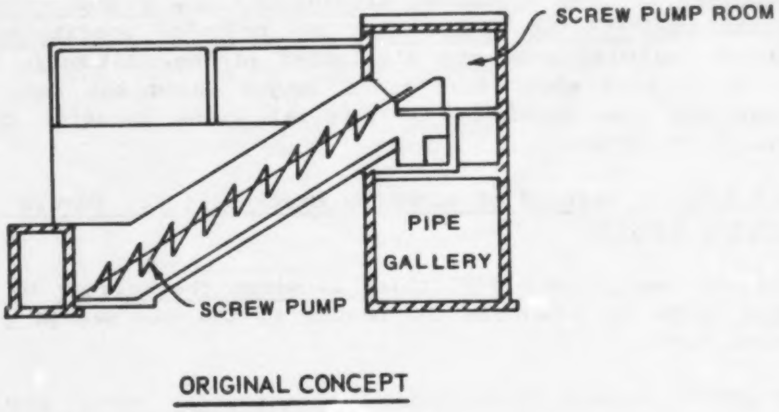

20'-0"
RETURN ACTIVATED SLUDGE HEAD TANK
MIXED LIQUOR CHANNEL
RETURN SLUDGE PUMP
RETURN ACTIVATED SLUDGE CHANNEL
ORIGINAL CONCEPT
31'-8"
RETURN ACTIVATED SLUDGE HEAD TANK
RETURN SLUDGE PUMP
MIXED LIQUOR CHANNEL
STAIRS IN THIS AREA
RETURN ACTIVATED SLUDGE CHANNEL
PROPOSED CONCEPT

Figure 15. Use vertical mixed flow pumps.


SCREW PUMP ROOM
PIPE
GALLERY
SCREW PUMP
ORIGINAL CONCEPT

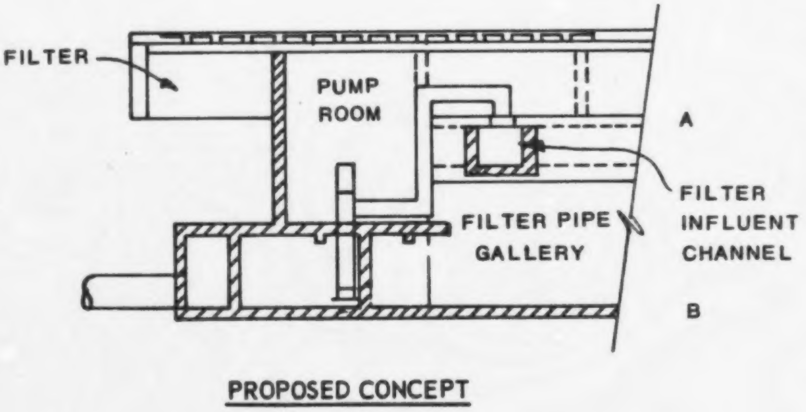

FILTER
PUMP
ROOM
A
FILTER
INFLUENT
CHANNEL
FILTER PIPE
GALLERY
B
PROPOSED CONCEPT

Figure 16. Use vertical mixed flow pumps instead of screw pumps.

Eliminate Digester Sludge Transfer Pumps

In the original design, two pumps were provided to transfer sludge from one digester to another.

The proposed concept suggested eliminating the sludge transfer pumps and using the recirculation pumps for the transfer operations. The proposal eliminated building area and simplified piping. Although the transfer of sludge would take about four times longer using the recirculation pumps, this was not considered to be critical since transfer of sludge is an infrequent operation.

Use Aluminum Zip-Rib Instead of Aluminum Checkplate for Covers on Pump Station and Pretreatment Complex

The initial design used 3/8" thick aluminum checkplates to provide walking surfaces above all channels and basins in the raw sewage pumping and pretreatment areas.

The proposed concept recommended a lightweight cover system of aluminum zip-rib. In the area of the comminutors and flumes, the aluminum checkerplate covers were retained to allow unrestricted access for plant personnel and the public as a viewing platform during tours.

FLOW MEASUREMENT

Eliminate Flow Meter

Flow to a chlorine contact chamber was originally through an 84-inch pipe, which was split into 2-54" pipes for diversion to two separate chlorine contact chambers. A metering pit was to be provided with valves and flow meters to divide the flow between the two contact chambers.

Deletion of the flow meters and associated valving was recommended, with control of the flow split to be accomplished hydraulically.

SCREENING

Use Existing Mechanical Screens

An existing facility was to be abandoned and a new 1.5 mgd plant was to be constructed a short distance away. All existing facilities were planned to be abandoned, and a pumping station was to be constructed to pump flow to the new plant. At the new plant, mechanically cleaned bar screens, with a standby manually-cleaned bar screen in a bypass channel, were included in the design.

Continued use of the existing manually cleaned bar screens at the existing plant prior to pumping to the new plant was recommended.

Eliminate Screw Conveyor

The original headworks design provided for screenings to be discharged from three bar screens onto a belt conveyor. The belt conveyor discharged into the hopper of an inclined screw conveyor. The screw conveyor dewatered the screenings and discharged to a screenings bin for transportation by forklift to the energy/solids building.

It was recommended to eliminate the screw conveyor and extend the belt conveyor to discharge directly into the bin. The bottom of the bin would be perforated to permit the screenings to dewater to the floor drain below.

Haul Screenings to Sanitary Landfill

The original idea was to incinerate screenings on site at the plant.

The proposed concept recommended reducing the energy requirements by eliminating the incinerator and hauling the screenings directly to a landfill where odor would not be a problem.

Use Mechanical Screen Instead of Barminutor

The original design included a barminutor in the head works.

The proposed concept recommended using a mechanical screen.

Eliminate Standby Mechanically Cleaned Bar Screen

The headworks was designed with two mechanically cleaned bar screens each having capacity for the entire plant flow. One of the screens was for normal operation and one was for standby.

The proposed concept recommended that the standby screen be converted to a manually cleaned screen.

GRIT REMOVAL

Grit Removal Channels in Lieu of Pista Grit Chambers

As originally designed, two pista grit chambers were provided for grit removal. An airlift was used to lift grit from each chamber into a slurry pipe for conveyance to a container.

The proposed concept recommended using four grit channels approximately eight feet wide by 50 feet in length. The grit would be handled using conventional collectors, conventional grit elevator, and conveyed using a screw-type conveyer. Sketches of the original and proposed concepts are shown in Figure 17.

Delete Grit Washer and Pump Directly to Sludge Storage Basin

As initially designed, the grit handling system included pumping grit from an aerated grit chamber to a grit washer and a grit cyclone. The grit was then to be hauled to a landfill for disposal.

To simplify the operation, it was recommended that the grit be pumped directly to sludge storage basins, which store digested, dewatered sludge prior to trucking to landfill. The proposal eliminated the need for separate grit treatment and hauling.

Eliminate Grit Washer and Use Cyclone

The original design included a grit system consisting of an aerated grit chamber, a grit washer and a grit cyclone.

The proposed concept recommended eliminating the washer and only using the aerated grit chamber and the cyclone to concentrate the grit.

Replace Tube Conveyor and Storage with Belt Conveyor and Dumpster

The original design of the headworks included the use of tube conveyors to transport screenings and grit to a storage tank.

The proposed concept recommended elimination of the silo storage tank and the tube conveyor and using a belt conveyor and a dumpster box.

Eliminate Truck Scale to Measure Grit Removal From Plant Site

Trucks were planned to remove dewatered grit from the plant site, and a truck scale was planned for truck weighing.

Elimination of the scale was proposed with grit measurement to be accomplished by measuring grit volume using marks on the side of the trucks. According to sand and gravel haulers, this technique should give about 1% accuracy. The uniform density of grit would be beneficial in attaining accurate results. At the plant under consideration, scales were also

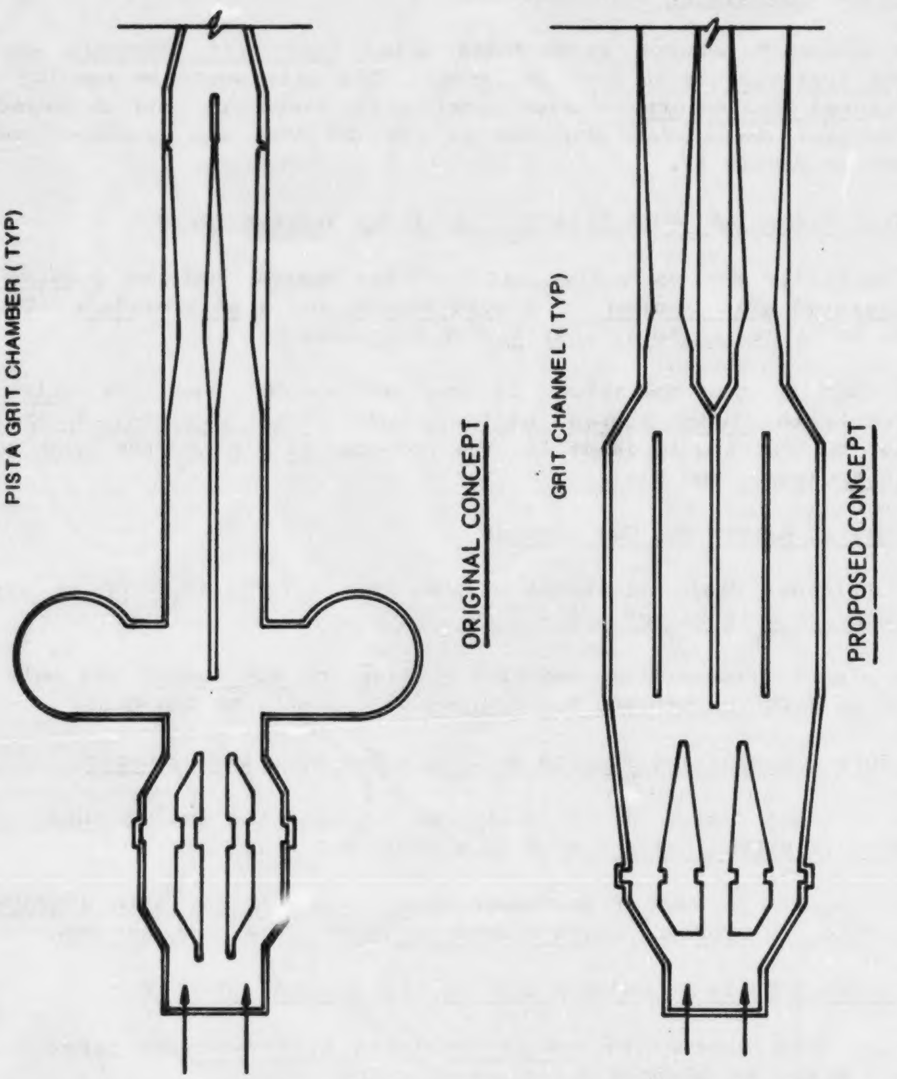

PISTA GRIT CHAMBER (TYP)
ORIGINAL CONCEPT
GRIT CHANNEL (TYP)
PROPOSED CONCEPT

Figure 17. Exchange grit channles for Pista grit chambers.

available in the digester area, and these were planned to be used on a periodic basis to check the accuracy of the proposed technique.

Simplify Grit Removal from Primary Sludge

Cyclone degritters were planned for degritting primary sludge. The plant was designed with four primary clarifiers, four sludge pumps and four cyclone degritters. The primary sludge pumps were to be located 600 feet from the cyclone degritters.

Use of one primary sludge pump and cyclone degritter for two primary clarifiers was proposed with a standby pump and degritter. Sketches of the original and proposed concepts are shown in Figure 18.

Use Aerated Grit Chamber in Place of Gravity Grit Chamber

The original concept proposed using a shallow gravity grit chamber in parallel with an existing unit of the same type. The new grit chamber would be built on a severely sloping grade, thus requiring foundation piles or other special support.

The proposed concept recommended using an aerated grit chamber to handle the entire design flow. Because of the greater depth involved with the aerated grit chamber, special foundations and retaining walls were not required. The existing gravity tank would be retained for periods when the aerated tank was out of service.

Substitute Low Head Grit Basins for Velocity Controlled

The original plan used two velocity controlled grit basins and a barminutor.

The proposed change recommended using two more reliable low head grit basins and a mechanically cleaned screen. The proposed system would provide continuous grit removal and would not be dependent on an operator.

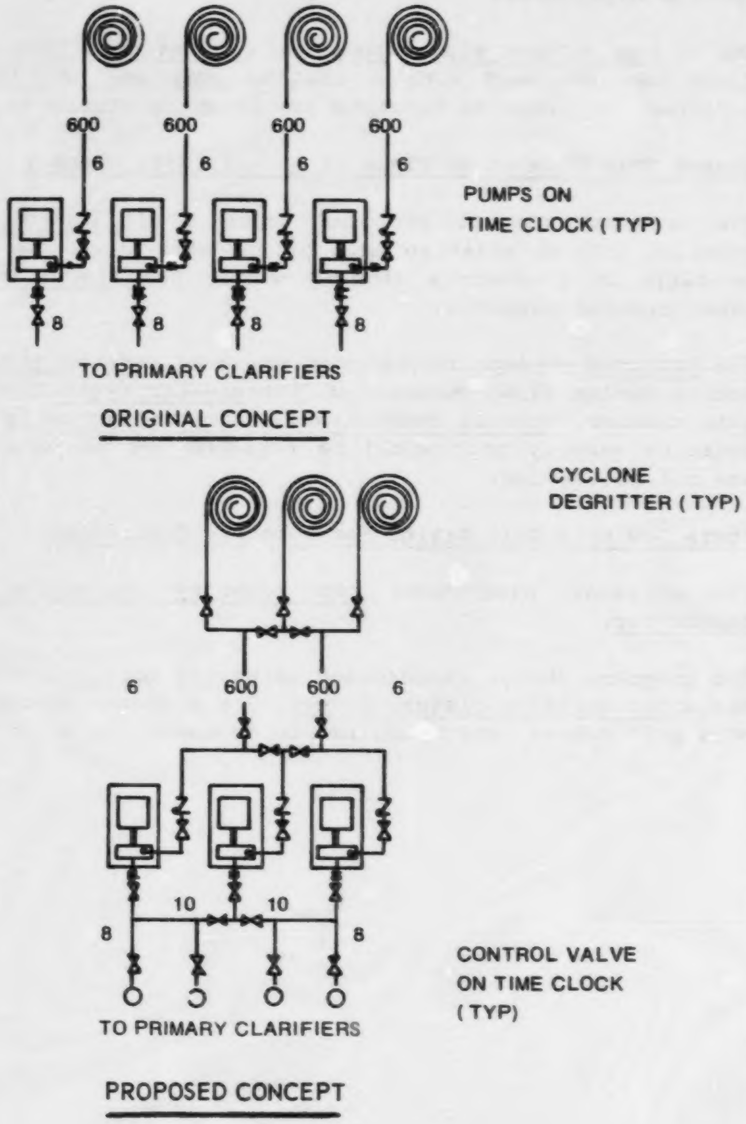

600
6
600
6
600
6
600
6
PUMPS ON
TIME CLOCK (TYP)
8
8
8
8
TO PRIMARY CLARIFIERS
ORIGINAL CONCEPT
CYCLONE
DEGRITTER (TYP)
6
600
600
6
10
10
8
8
CONTROL VALVE
ON TIME CLOCK
(TYP)
TO PRIMARY CLARIFIERS
PROPOSED CONCEPT

Figure 18. Simplify grit removal.

CLARIFIERS

Replace Primary Effluent Channel with Pipe

Effluent from the primary clarifiers originally was collected in a common channel and piped over an interstage pumping station.

The proposed concept recommended replacing the effluent channel with a pipe and transferring the effluent directly to the interstage pumping station. A sketch of the before and after concepts is shown in Figure 19.

Eliminate Low Air Pressure Scum Control System

In the original design concept, rectangular primary sedimentation basins were equipped with a low pressure directional air system to move the scum to the head end of the basin. The basin also had an air scrubber system for odor control.

The proposed concept recommended eliminating the low pressure directional air system for scum removal and replacing it with more positive, less energy intensive, collection mechanisms using flights or separate drive system. The recommended system reduced the required odor scrubbing capacity needed for the system. Figure 20 shows sketches of the original and proposed concept.

Eliminate Settling Tubes in Secondary Clarifiers

The initial design of rectangular secondary clarifiers included tube settlers in the last 115' of each clarifier basin.

The proposed recommended eliminating the tube settlers to reduce construction and O&M costs. Although some loss of suspended solids removal efficiency would occur, the change was considered negligible.

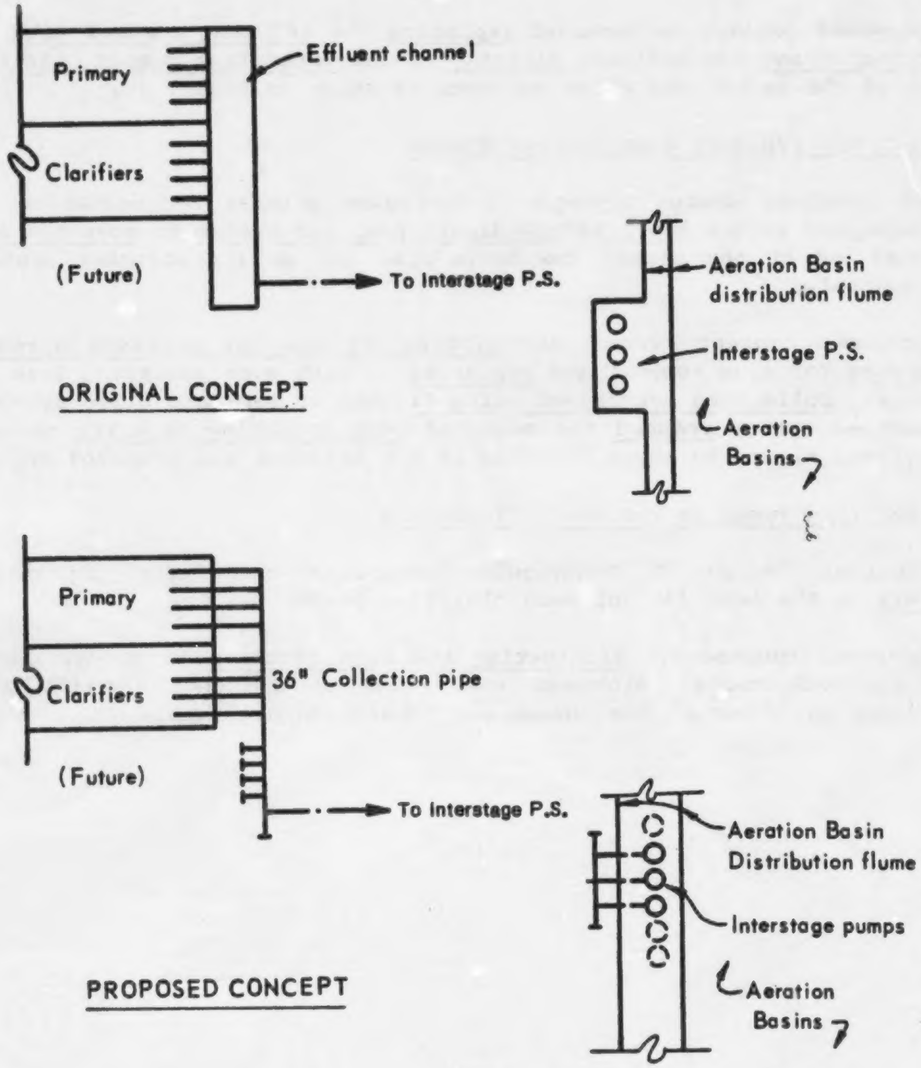
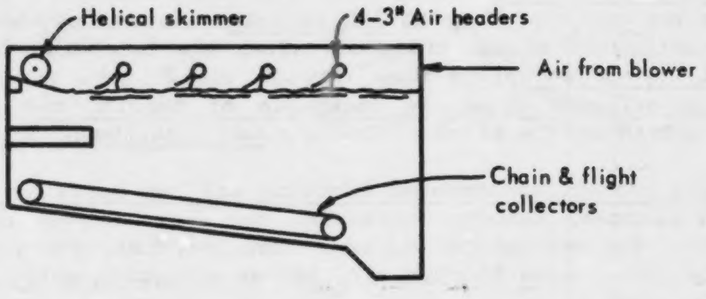
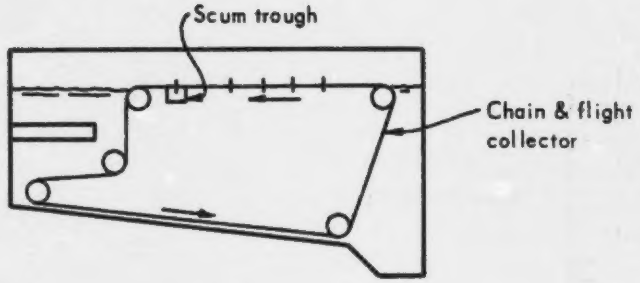

Primary
Effluent channel
Clarifiers
(Future)
To Interstage P.S.
Aeration Basin distribution flume
Interstage P.S.
Aeration Basins
ORIGINAL CONCEPT
Primary
Clarifiers
36" Collection pipe
(Future)
To Interstage P.S.
Aeration Basin Distribution flume
Interstage pumps
Aeration Basins
PROPOSED CONCEPT

Figure 19. Replace primary effluent channel with pipe.


Helical skimmer
4–3" Air headers
Air from blower
Chain & flight collectors

ORIGINAL CONCEPT


Scum trough
Chain & flight collector

PROPOSED CONCEPT

Figure 20. Replace low pressure air scum control system with collection mechanism.

TRICKLING FILTERS

Modify Existing Distributor Instead of Replacing

An existing plant used a trickling filter to treat primary effluent. To maintain sufficient flow through the distributor and the trickling filter, the system was capable of up to 50% recycle. Planned upgrading of the plant by adding activated sludge treatment after the trickling filter eliminated the capability of recycling flow through the filter, and without recycle, the primary effluent flow was incapable of turning the distributor arm. Plans for upgrading the plant included a new distributor arm.

The proposed concept recommended blocking off two opposing distributor arms with blind flanges, thereby increasing the flow through the remaining two arms by 50%. The assumption was made that the distributor should turn satisfactorily with 2 arms blocked off, but an alternate solution was to remove two opposing arms.

AERATION SYSTEM

Change Air Piping Material

In the original design concept, a steel cylinder concrete pipe was utilized from the blower building to the aeration basins, with ductile iron pipe used for distribution at the aeration tanks.

A piping material change from the steel cylinder concrete pipe and ductile iron pipe to steel pipe with multiple wrap coating was proposed.

Increased Aeration Basin Depth Change Type of Diffusers

An aeration basin depth of 15 feet and fine bubble dome diffusers were used.

An increase in the aeration basin depth from 15' to 20' was proposed, and change to coarse bubble static diffusers to increase oxygen transfer efficiency, and reduce power costs.

Emergency Drive of Air Compressors for Pure Oxygen Plant

Pure oxygen was to be generated on-site for use in secondary treatment. Three 20 ton/day units were planned, two for normal operation and one for back-up unit. Each of the air compressors was driven by an electrical motor under normal operation, and during a power outage, any two of the three could be driven by gas engines. Digester gas would be used as the gas source for these engines.

The proposal concept recommended using two air compressors, each rated at 100% of required capacity. A single gas engine, which could drive either of the compressors, was proposed for use during power outages. A sketch of the original and proposed concepts is shown in Figure 21.

Use Smaller Blower for Low Pressure Air Supply

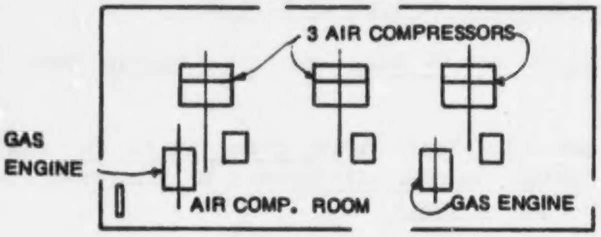
In the original concept, low pressure air for aerating the aeration tank influent and effluent channels was taken off the high pressure line to the aeration tank.

The proposed concept recommended two low pressure blowers (one or standby) with an equivalent reduction in the main blower size.

Use Welded Steel Pipe in Place of Flanged Ductile Iron Pipe

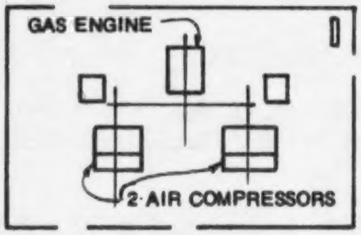
In the original design, pipe from the air blower building was specified to be flanged ductile iron piping.

The proposed concept recommended using welded steel or stainless steel blower piping.


3 AIR COMPRESSORS
GAS ENGINE
AIR COMP. ROOM
GAS ENGINE

FIRST FLOOR PLAN

ORIGINAL CONCEPT


GAS ENGINE
2 AIR COMPRESSORS

FIRST FLOOR PLAN

PROPOSED CONCEPT

Figure 21. Emergency drive for pure oxygen air compressor system.

Use Plastic Insert Type Venturi Meters for Airline Metering

The original concept proposed using venturies on the aeration lines.

In the proposed concept plastic insert type venturies with a 20 year life are used for airline metering.

Reduce Number of Blowers, Use Dual Drive, and Increase Speed

The original concept for the aeration system was to use six blowers operating at 1200 RPM. Three blowers were to be motor driven, two dual fuel (methane and natural gas) engine driven, and one engine driven using only methane. To provide the required air delivery, only 4 of the 6 blowers were required.

The proposal was to use four 1750 RPM blowers which were dual drive, motor or engine driven. When digester gas was available, the blower would be driven by the engines, and during other times by the motors. Three of the units were for normal operation, and one was standby. A sketch showing the before and after concepts is shown in Figure 22.

Move Blower Building Closer to Aeration Basin

A blower building was to be constructed to provide air to a new nitrification basin.

The proposed concept recommended moving the blower building to allow a common wall with the new nitrification basins.

Mechanical Aeration to Replace Diffused Aeration in 1st and 2nd Stage Aeration

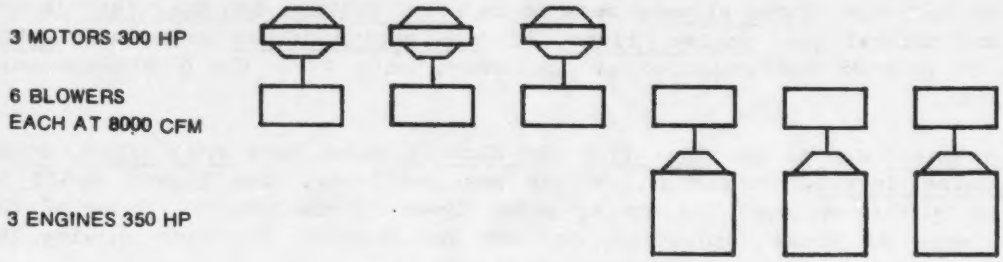
The original concept utilized a diffused air system for first and second (nitrification) biological treatment. The first stage was completely mixed and the second stage was plug-flow.

The proposed concept recommended using mechanical surface aerators instead of the swing diffuser aerators. Aerators were proposed to be dual speed in the 1st stage aeration with one aerator per aeration basin. To vary aeration capacity in the 2nd stage, two dual speed aerators were recommended in each 2nd stage aeration basin.

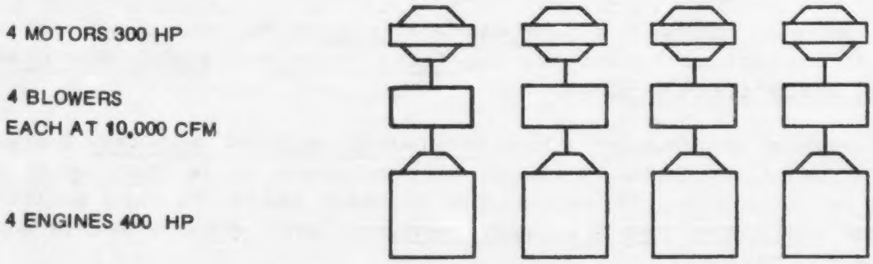
Lift Out Drop Pipes Instead of Swing Drop Pipes

Aeration basins were designed with "tee" walls between the basins, and the walkway between basins was at the top of the "tee". The main air header was attached to the underside of the tee, and was used to supply air to basins on each side of the tee wall. Between the diffusers and the main air header were swivel joint (top) and knee jointed (mid-point) drop pipes.

The proposal was to replace the swivel joint drop pipes with lift out drop pipes. To check diffusers, the lift out pipes would be disconnected at a


3 MOTORS 300 HP
6 BLOWERS
EACH AT 8000 CFM
3 ENGINES 350 HP

ORIGINAL CONCEPT


4 MOTORS 300 HP
4 BLOWERS
EACH AT 10,000 CFM
4 ENGINES 400 HP

PROPOSED CONCEPT

Figure 22. Use dual drives for blowers.

quick disconnect joint, and then lifted out. A sketch of the original and proposed concepts is shown in Figure 23.

Constant Speed, Centrifugal Blowers Instead of Variable Speed, Positive Displacement Blowers

The original design proposed rotary positive displacement blowers with variable speed drive motors to control the volume of air and power consumption for the aeration system.

The proposed alternate was to install centrifugal type blowers with constant speed drives and use valves to throttle the blower to vary the air volume and power consumption.

Use Fixed Headers for Air Supply Piping

The original aeration concept was a high efficiency fine bubble diffusion system, using drop pipes from a main aeration header near the top of the basins.

The proposed concept recommended installing the main air header at the bottom of the tank, and attaching the tube headers directly to the main air header. This concept eliminates the need for drop pipes and fitting, but it would require the basin to be dewatered for diffuser maintenance.

Fine Bubble Diffusion in Lieu of Coarse Bubble Diffusion

The original concept proposed coarse bubble diffusion as the oxygen transfer system for both secondary and nitrification aeration.

The proposed concept recommended switching to fine bubble diffusion because of the higher transfer efficiency and lower energy costs.

Replace Air Flow Tubes with Orifices

The original concept used flow tubes for measurement of air flow to the aeration basins.

The proposed concept would use flange mounted orifice plates to measure air flow.

Mechanical Surface Aerators in Place of Diffused Air System

The original concept used conventional diffused air system utilizing blowers, a blower building, air distribution piping, and baffle walls in aeration basins.

The proposed concept would utilize mechanical surface aerators which provide a more efficient oxygen transfer and eliminate the need for a blower building, blowers, and baffle walls.

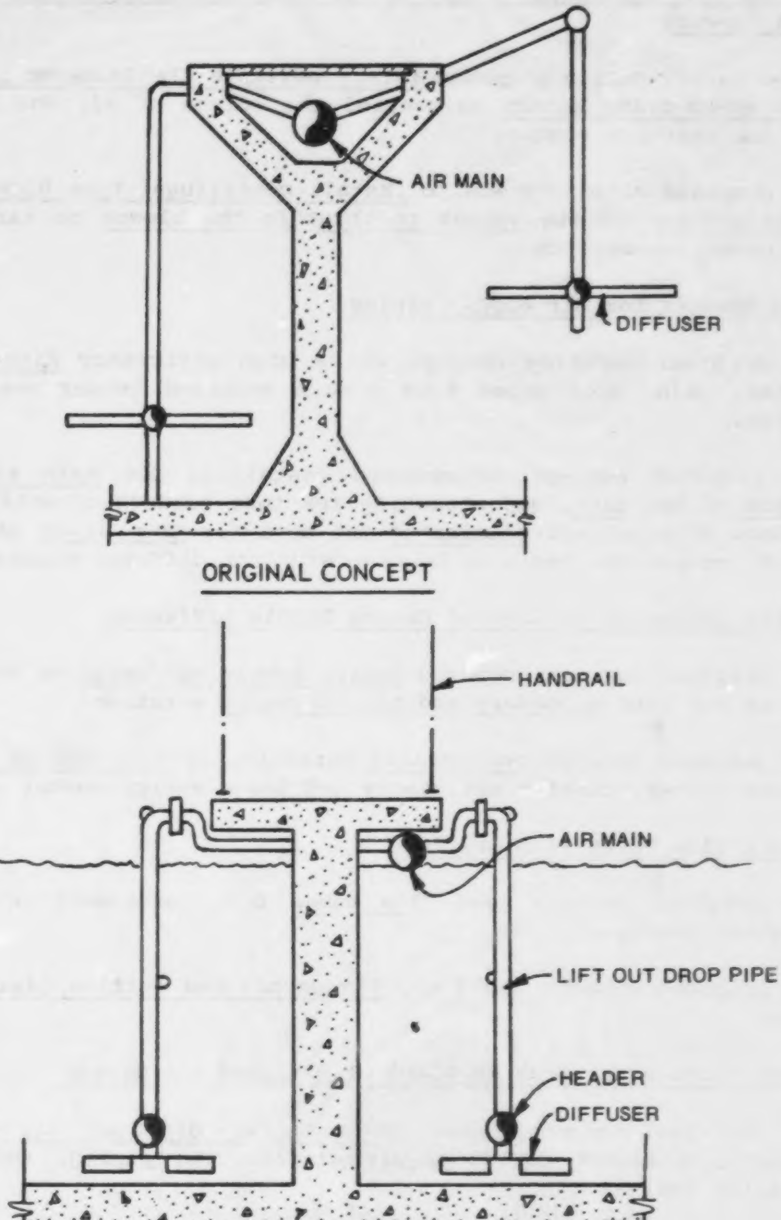

AIR MAIN
DIFFUSER
ORIGINAL CONCEPT
HANDRAIL
AIR MAIN
LIFT OUT DROP PIPE
HEADER
DIFFUSER
PROPOSED CONCEPT

Figure 23. Replace swing drop pipes with lift out drop pipes.

Use Single-Louver Control System

In the original concept, louvers on aeration tank blower inlets were individually controlled. A louver would be opened and closed with the corresponding blower, with the amount of opening regulated by the air pressure in the inlet air channel. As designed, the system could search for the correct louver opening, with louvers fighting each other unless complicated control systems were used.

In the proposed concept, only one control system would be used to regulate the opening of all the louvers online. This number of louvers open would vary from one to five louvers depending upon the number of blowers operating, whether screens were clogged by leaves or snow, or other conditions. The proposal eliminates four sets of controls and associated hardware, software, and engineering.

Use Common Air Piping for Aeration

The original concept proposed one air header pipe for each aeration basin.

The proposed concept recommended using one air header for each two tanks. A header pipe for a single basin was only required when there was an odd number of aeration basins.

Provide Single-Stage Oxygen Plant

The original concept used a two-stage activated sludge system with carbonaceous BOD removal in the first stage and nitrification in the second stage. The plant utilized a pure oxygen process for each stage.

In the proposed concept a single-stage pure oxygen activated sludge was used, thereby eliminating the intermediate clarification step and providing a more compact plant.

Substitute Pressure Swing Adsorption for Cryogenic Oxygen System

In the original concept pure oxygen aeration was used for the two stage activated sludge system. The oxygen was provided through cryogenic generation which has a limited turndown capacity.

In the proposed concept pressure swing absorption oxygen generation was used thus providing substantial turndown capability to meet various oxygen requirements.

Substitute Anaerobic Filter for Periodic Peak Load Treatment

In the original concept the treatment plant was designed to treat the average flow with a two-stage aerobic biological process. This treatment scheme included treating a seasonal wasteload from a food processing plant.

In the proposed concept the food processing plant waste was pumped to the treatment plant in a separate pipeline. The proposed treatment for the food processing plant waste would be an anaerobic filter, which would recover energy as methane gas and reduce the BOD load to the plant. The design peak BOD to the main plant would be reduced 37.7% and average loadings 19.5% using this concept. The existing trickling filters would be renovated for the anaerobic filters by adding covers, improving underdrain structure and providing radial collector pipes from the existing turntable structure.

Change Aeration Basins to Complete Mix Activated Sludge

The original design included an aeration system consisting of long narrow basins designed to permit plug flow, step feed, or contact stabilization activated sludge. The return activated sludge piping and inlet piping were set-up to permit any and all of the above variations.

It was recommended that the basins be converted to complete mix basins in a single activated sludge operating scheme. The basins for complete mix eliminated much of the piping and intermediate walls associated with the original design. The proposed and original concepts are shown schematically in Figure 24.

Eliminate Spray System in Aeration Tanks

The original design concept included froth control using spray headers and nozzles around the aeration basins.

The proposed concept recognized that froth was not a problem in the existing plant and that it would not be a problem in the new plant, except during plant startup. It was recommended to eliminate the froth control system in order to lower construction cost.

Submerged Turbines Instead of Diffused Air

In the original design, aeration was to be provided using centrifugal blowers.

It was recommended that submerged turbines be installed in the basins and new smaller centrifugal blowers, with a lower operating cost, be used.

Remove Covering from Biofilters

The initial design concept included two biofilters covered with geodesic domes.

It was proposed to use the same filters and remove the covers.

Replace Mixed Liquor Channel with Pipe

Originally, the mixed liquor from the aeration basin discharged to a channel which passed between the secondary clarifiers and was used to distribute the flow.

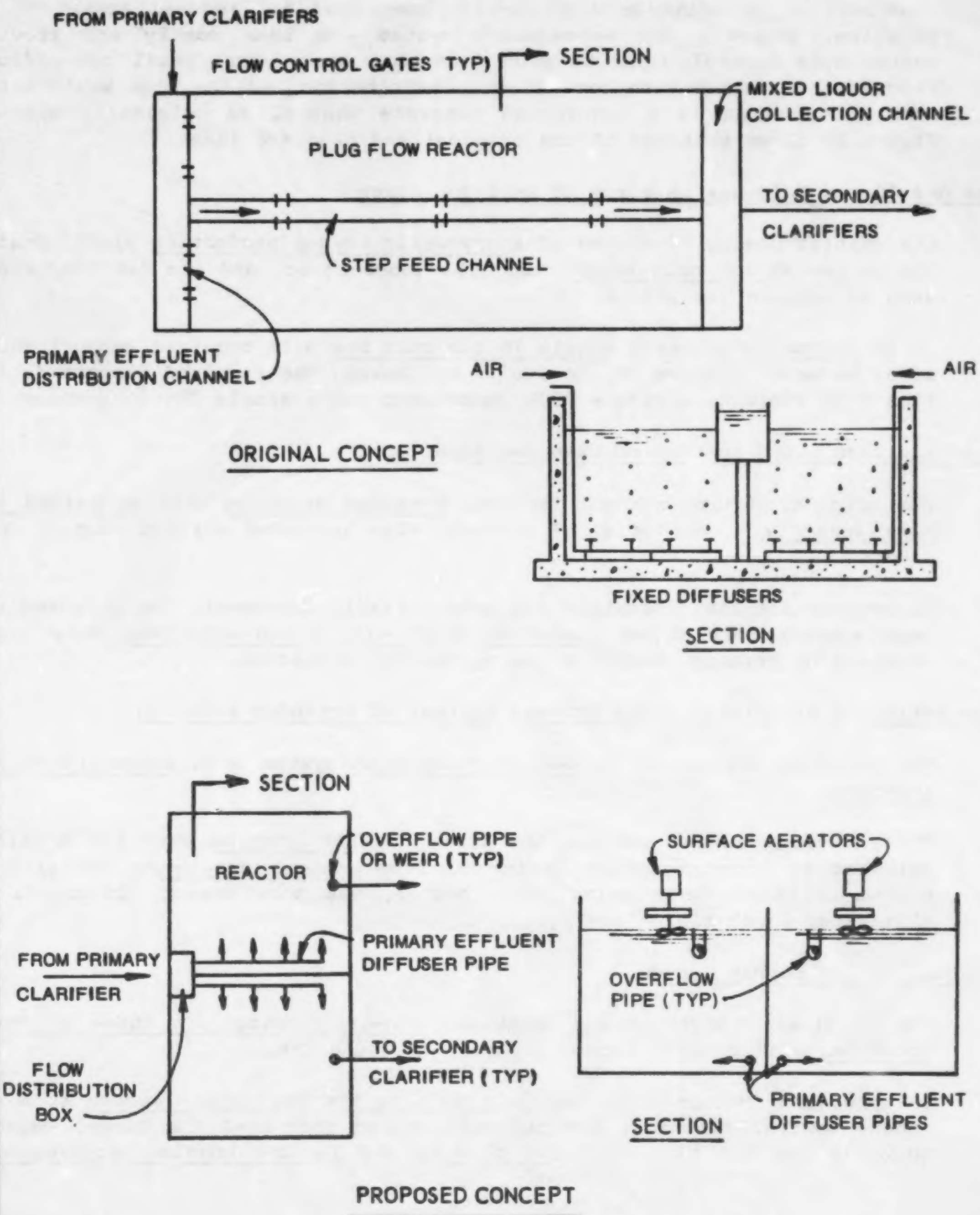

FROM PRIMARY CLARIFIERS
FLOW CONTROL GATES TYP)
SECTION
MIXED LIQUOR
COLLECTION CHANNEL
PLUG FLOW REACTOR
TO SECONDARY
CLARIFIERS
STEP FEED CHANNEL
PRIMARY EFFLUENT
DISTRIBUTION CHANNEL
AIR
AIR
ORIGINAL CONCEPT
FIXED DIFFUSERS
SECTION
SECTION
OVERFLOW PIPE
OR WEIR (TYP)
REACTOR
SURFACE AERATORS
PRIMARY EFFLUENT
DIFFUSER PIPE
FROM PRIMARY
CLARIFIER
OVERFLOW
PIPE (TYP)
TO SECONDARY
CLARIFIER (TYP)
FLOW
DISTRIBUTION
BOX
PRIMARY EFFLUENT
DIFFUSER PIPES
SECTION
PROPOSED CONCEPT

Figure 24. Use complete mix activated sludge.

The proposed system was to replace the MLSS channel with pipe and distribution boxes at each pair of secondary clarifiers. This system required the construction of multiple distribution boxes and had reduced access to the pipeline. However, the recommended system was less costly and provided better scum control since no scum formation would occur until the effluent reached the distribution box. At the distribution box the scum would settle much better than in a reinforced concrete channel as originally planned. Figure 25 shows sketches of the original and proposed ideas.

Use One 70 ton Cold Box in Place of 2-35 Ton Boxes

The initial design consisted of a cryogenic oxygen production plant consisting of two 35 ton cold boxes, two 100% compressors, and two 70% compressors used as support facilities.

It is recommended that a single 70 ton cold box with required support facilities be used in place of the two 35 ton boxes. The required support facilities then included a single 100% compressor and a single 70% compressor.

Use Oxidation Ditch Instead of Extended Aeration

The original design concept included extended aeration with submerged turbine aerators. The original concept also provided aerobic digestion of sludge.

To provide simplier operation and more reliable treatment, the proposed concept suggested using an oxidation ditch with brush aeration. This system required no primary treatment and no aerobic digestion.

Use Activated Bio-Filter (ABF) Process Instead of Extended Aeration

The original design was an extended aeration system with submerged turbine aerators.

The proposed concept recommended using the ABF process with the biofilter followed by short aeration basin using mechanical aerators. The proposed system could tolerate shock loads better, was more energy efficient, and eliminated equalization storage.

Centralize Air Supply System

The original design concept included blowers located at three different locations with a total blower capacity of 2,000 CFM.

The proposed concept suggested centralizing the air supply system at a secondary control building. The proposed design increased the blower capacity to 2,500 CFM, but eliminated two blowers, and reduced housing requirements.

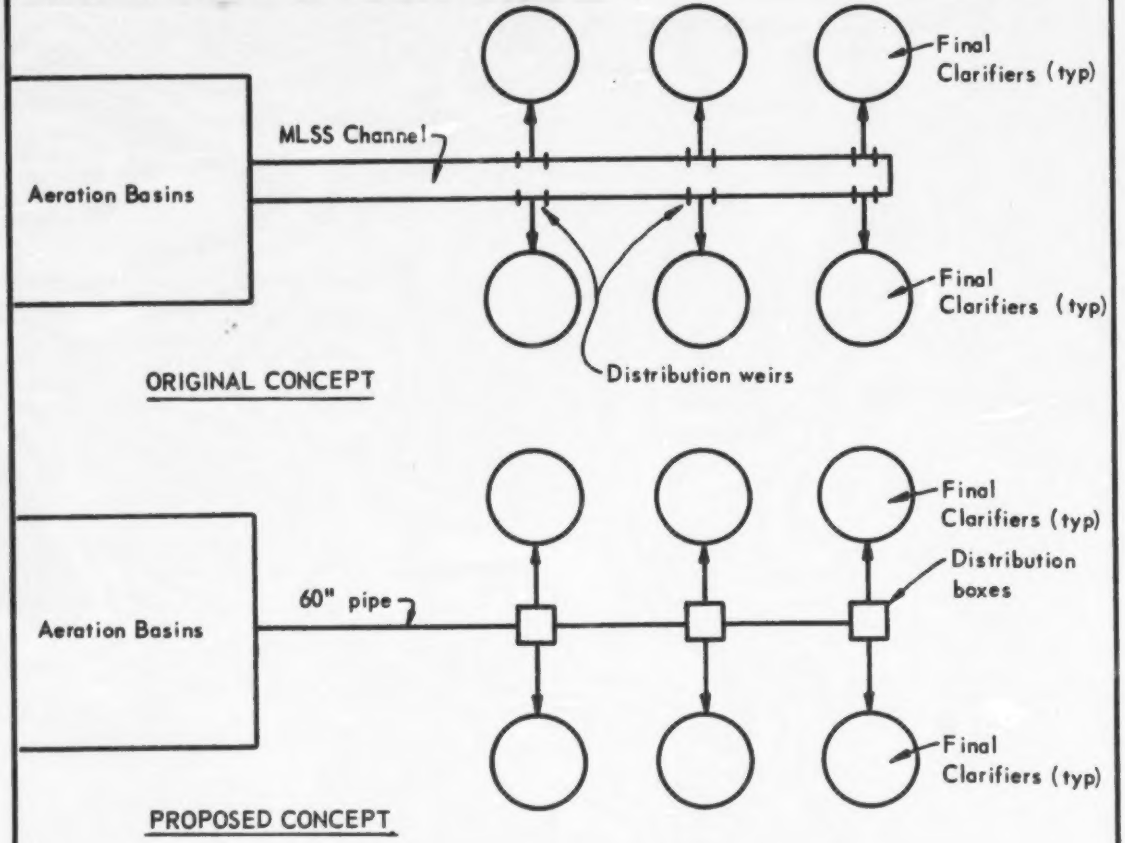

Aeration Basins
MLSS Channel
Final Clarifiers (typ)
Final Clarifiers (typ)
Distribution weirs
ORIGINAL CONCEPT
Aeration Basins
60" pipe
Final Clarifiers (typ)
Distribution boxes
Final Clarifiers (typ)
PROPOSED CONCEPT

Figure 25. Replace mixed liquor channel with pipe.

Use Aluminum Covers Rather Than Concrete Over Aeration Basins

The original design of the aeration basins in a pure oxygen plant included concrete slab covers.

The proposal recommended using aluminum covers in place of concrete slabs.

DISINFECTION

Use Ozone Instead of Chlorine

The plant utilized high rate trickling filters for carbonaceous BOD removal, and pure oxygen activated sludge for nitrification. On-site oxygen generation facilities were planned. Chlorine with dechlorination was required for effluent disinfection.

The proposed concept recommended using ozonation instead of chlorination, since pure oxygen generation facilities were already planned for the site.

Reduce Chlorine Contact Basin Size

Plant effluent was disposed to a deep-well system near the plant site. A chlorine contact basin was used to meet disinfection requirements prior to flow diversion to the deep-well system.

Use of the deep-well system capacity to provide a portion of the overall chlorine contact time, similar to an outfall, was proposed. This proposal resulted in a 40% reduction in the size of the chlorine contact chamber.

Use Tank Trailer for SO_2 and Cl_2 Storage

The original concept used large cylinders for SO_2 and Cl_2 storage in a building.

The proposed concept recommended using tank trailers with a capacity of 18 tons each to deliver and store SO_2 and Cl_2. The required building size would be reduced by 2300 square feet.

Revise Location of Chemical Injection Points

The original concept was for chlorine contact tanks which provided approximately 15 minutes detention time from the tank inlet at maximum flow.

The proposed concept was to move the point of chlorine application from the inlet of the chlorine contact tank upstream and also to move the point of the sulfur dioxide application from the outlet of the chlorine tank downstream. The lengths of influent conduit and effluent conduit would provide additional contact time for the chlorine. The additional volume in these conduits permitted shortening of the contact tanks, and reducing the number of concrete piles, excavation and backfill.

Reduce the Number of Chlorine Cylinders

The original design concept included room for two operational cylinders, plus a storage capacity for fifteen chlorine cylinders. A bridge crane was provided to move the cylinders. The chlorine system was designed to provide disinfection for the entire plant flow.

The proposed concept recognized that it was not necessary to provide disinfection for the entire plant flow and that only the portion of flow used for reclamation needed be chlorinated. The proposal recommended cutting the storage area in half to provide room for five cylinders plus an area for the two operational cylinders. Also, it was recommended that the bridge crane be replaced with a monorail crane.

Reduce Chlorine Contact Chamber Size

In the original design, the chlorine contact tank and three chlorinators were sized for disinfecting the entire plant flow. A portion of the flow was to be used as reclaimed water.

In the proposed recommendation, the chlorinators would continue to be sized for all of the plant flow, but the size of the chlorine contact tanks would be reduced so that only a portion of the effluent would enter. The reclaimed water would attain an adequate contact time while in plug flow through the pipeline to its reclamation use.

Eliminate Chlorine Contact Tank Bypass

The treatment facilities were to be constructed in two phases. In the original phase, a chlorine contact basin bypass line was to be constructed in order to facilitate the additional chlorine contact basins construction. The chlorine contact basin drains connected to the bypass line.

It was recommended to eliminate the bypass under the chlorine contact tank. The proposed change would result in some loss of flexibility during construction. However, the effluent flumes would permit operation of the contact basins while the new basins are being constructed. The entire flow would be diverted to one-half of the chlorine contact facilities for short periods when the new basins were being connected into the flumes.

Ton Containers Instead of 150 lb Containers for Cl_2 and SO_2 Containers

The original design called for chlorine and sulfur dioxide to be dispensed from 150 lb cylinders with tank-mount type gas feeders.

The proposed concept recommended dispensing chlorine and sulfur dioxide from 1-ton cylinders with the same type of feeders. The proposed system would provide less frequent changeovers and more reliability due to increased storage capability.

Replace SO_2 Mechanical Mixer with a Hydraulic Mixer

The initial design mixed SO_2 with plant effluent by mechanical jet mixer.

The proposed concept suggeted mixing the SO_2 by hydraulic mixing at the chlorine contact basin effluent weir.

Simplify Chlorine Scrubbing System

The initial design included a chlorine scrubbing system to collect and scrub chlorine gas in the event of a chlorine cylinder break.

Realizing the high expense of this system, the VE team recommended eliminating spent caustic storage, redundancy in pumps and fans, and all but the most basic controls. The proposed system layout consisted of a scrubber, pump, a 3500 gallon sump tank, and a chlorine detection system to automatically start the system. The sump tank would be filled with caustic solution from 55 gallon drums and diluted with water to a 10% concentration. When the scrubber system was activated, the contents of the system would be pumped through the scrubber and then back into the sump. Solution would continuously recirculate until the emergency passed and the scrubber shuts down. The sump could then be drained and refilled as needed after emergencies to supply fresh caustic.

Reduce Dechlorination Tank Size

The original concept used open channel mixing of sulfur dioxide in the dechlorination step, followed by 5 minutes detention in a baffled channel.

In the proposed concept, a flash mixer for instantaneous contact was used, followed by a contact basin with about one-half the original contact time.

FILTRATION

Package Steel Filters Replacing Reinforced Concrete Structures

Filters for tertiary filtration were to be constructed using reinforced concrete tanks.

Package steel tanks were proposed as a substitute for the reinforced concrete structures, with the filters constructed and shipped for immediate installation. Concrete channels were to be used for influent distribution, while filter effluent and overflow connections to the filter were by means of header pipes.

Use Surface Washers in Place of Air Scour

The original concept proposes to use blowers to provide air scour for supplemental agitation during filter backwash. Blowers were provided in each filter gallery.

The proposed concept would use a surface wash system which would consist of turbine pumps with two surface arm washers per filter located just above the media. The nozzles on the wash arms will both rotate the arms and agitate the media.

Use One Backwash Rate Controller in Place of Two

The original concept used one backwash pump in each of two pipe galleries, and an interconnection pipe between galleries. The pump arrangement required two 24-inch backwash rate of flow controllers.

The proposed concept recommended locating both backwash pumps in one filter gallery and eliminate one backwash rate flow controller. Motor controls would be all located in the same area.

Eliminate Effluent Rate Controllers on Declining Rate Filters

The original concept proposed declining rate filters for filtration. It also included rate of flow controllers on the effluent from the filters.

The proposed concept recommended eliminating the rate of flow controllers because the declining rate filter concept assumes a declining rate flow through each filter as the head loss increases and a splitting of flow between the filters based on the varying head losses. In order to control the maximum rate of flow through the filter it was proposed to calibrate the rate of the flow through the effluent butterfly valve by using orifice plates or a propeller meter.

Replace Hydraulic Valve Operation System with Pneumatic System

The original concept proposed to use a hydraulic valve operation system for filter process valves.

The proposed concept would replace the hydraulic system with pneumatic valves for all process valves, and delete the fluid return pipe system.

Reduce Gullet Width by One Foot

The original concept proposed using 5 foot wide gullets in the filters.

The proposed concept would reduce the overall structure length by reducing the gullet width to 4 foot (without affecting the backwash operation).

POST AERATION

Use Turbine Aerators

An existing chlorine contact chamber was to be converted to a post-aeration basin, with diffused aeration being used to supply the air and turbulence required for reaeration.

Submerged turbine aerators were proposed to provide the required air and turbulence.

Cascade Aeration Replacing Pure Oxygen

Pure oxygen was to be stored on-site and fed after the chlorine contact chamber to add dissolved oxygen to the plant effluent.

Little head loss was available for the plant effluent, but sufficient head loss was available for a cascade type aeration chamber immediately after the chlorine chamber.

CHEMICAL FEED

Consolidate Lime Feed Systems

A 4 mgd facility was being expanded by 14 mgd, but because of site limitations there would be two distinct plants on the site. Lime feed systems were proposed to control pH prior to nitrification, and separate lime storage and feed systems were proposed for the "old" plant and the "new" plant.

The proposed concept was to utilize the lime storage and feed facilities for the plant expansion as a centralized lime feed system for the entire site, and to convey slaked lime from the central facilities by a series of open channel troughs to the "old."

Use Larger and Fewer Lime Feeders

Eight lime storage silos, each with 3750 cubic feet of storage capacity were in the original design. A separate lime feeder was utilized for each of the silos.

It was proposed that the silo capacities be increased from 3750 cubic feet to 5000 cubic feet each, and that the number of silos be decreased from 8 to 6.

Bulk Storage and Handling for Chlorine and Sulfur Dioxide

In the original design, the disinfection system included the use of ton cylinders for chlorine and sulfur dioxide.

Recognizing the possible unreliability of the original concept the proposed concept recommended using a safer more economical bulk storage and handling of these chemicals rather than ton cylinders.

Eliminate Lime Slurry Feeders

From a lime slaker, lime slurry was conveyed to a mix tank and then to four smaller tanks. Two dual head metering pumps were used to feed from the four smaller tanks to four application points.

One large lime slurry tank complete with mixer was proposed to replace the original system of the mix tank and the four individual tanks. A circulation loop would be set up and fed by recirculation pump. At each of the lime discharge points, control valves would be used to control the rate of lime addition. The recirculation loop, recirculation pump, and the control valves replace the metering pumps.

Purchase Carbon Under a Separate Contract

The original design obtained carbon for charging the carbon adsorption system under construction contract.

The proposed concept would let a separate contact under separate bid for purchase of carbon.

SLUDGE COLLECTION

Replace Chain Drag Sludge Collector with a Traveling Bridge Sludge Collector

Twelve clarifiers were utilized for removal of 1st stage biological sludge, each clarifier being 15' wide. Sludge collection was by chain drag units, one for each 12 basins, to hoppers at the influent end of the basins. Separate air lift pumps were used for sludge removal from each basin.

The proposal was for elimination of the chain drag units and the air lift units, and substitution of a traveling-bridge type sludge collector. Additionally, the number of clarifiers was to be reduced from 12 basins 15' wide to 6 basins 30' wide. The traveling-bridge mechanism which was proposed would be adapted to operate on two of the 30' wide clarifiers at the same time. Submerged perforated pipe weirs were recommended for effluent collection instead of the original "v"-notch weir and trough system.

Use Non-Metallic Chains in Primary Clarifiers

The original concept utilized cast iron chains and redwood flights.

The proposed concept recommended that non-metallic chains be utilized as a substitute for the cast-iron chains.

SLUDGE THICKENING

Reduce Number of Gravity Thickeners

Four gravity sludge thickeners, each 45 feet diameter with a 10 foot sidewater depth were used in the original design concept.

Reduction of the number of units from four to two was proposed, with the diameter of the thickeners increasing from 45 foot to 60 foot diameter thickeners being used in the proposal.

Rearrange Dissolved Air Flotation Units

Two dissolved flotation thickeners were arranged with a 14' wide gallery located between the thickeners. This gallery contained all the drive units, thickened sludge pumps, and a thickened sludge storage tank.

Elimination of the gallery between the units and use of a common wall between the units was proposed. A much smaller gallery was constructed at one end of the units to contain the pumping equipment, and the sludge storage tank was eliminated. The proposal substantially reduced the required building floor area, as well as the quantity of required piping.

Change Bottom Slope of Primary Clarifier

Originally, the primary clarifier was intended to provide both clarification and sludge thickening to approximately a 5% solids content. To accomplish this degree of thickening a dual-slope bottom was used for the clarifier, and polymer was planned to be used in subsequent sludge treatment if 5% solids could not be obtained in the clarifier.

The proposed concept recommended modification of the clarifier bottom to a constant slope bottom and the addition of a separate gravity sludge thickener. The proposal was based upon the anticipated advantages of better overall clarifier operation, and a greater likelihood of achieving a 5% solids concentration in the thickener than in the clarifier. A sludge thickener should more consistently produce a 5% solids concentration sludge, thereby reducing polymer costs.

Use Gravity Thickeners For All Sludge

A pure oxygen activated sludge plant was designed to use gravity thickening for the primary sludge and dissolved air flotation (DAF) for the pure oxygen secondary sludge. The anticipated concentration for the DAF product was 4% solids. Both the gravity thickeners and the DAF units were enclosed in a building.

The proposed concept recommended using gravity thickeners for thickening both the primary and secondary sludge. Although gravity thickening of biological secondary sludge is difficult, the proposal was based upon the experienced ability of pure oxygen activated sludge to be thickened to 4% using gravity thickeners. The building included in the original proposal was eliminated.

Convert Gravity Thickeners to Air Flotation Thickeners

The original concept proposed to construct two air flotation thickening tanks with a total of 1600 square feet of area for concentration of waste activated sludge.

In the proposed concept two of the existing gravity thickeners, with a total surface area of 2500 square feet, would be converted and used as air flotation thickeners.

Thickening of Waste Activated Sludge (with chlorine addition)

The original concept proposed use of air flotation to concentrate waste activated sludge.

In the proposed concept existing 40-foot diameter gravity thickeners would be used to thicken the waste activated sludge. Chlorine was to be used to aid in the thickening process. It was estimated that approximately 100 mg/L of chlorine would be required for the thickening process.

Eliminate Pump Suction Control Valves and Magnetic Flow Meters

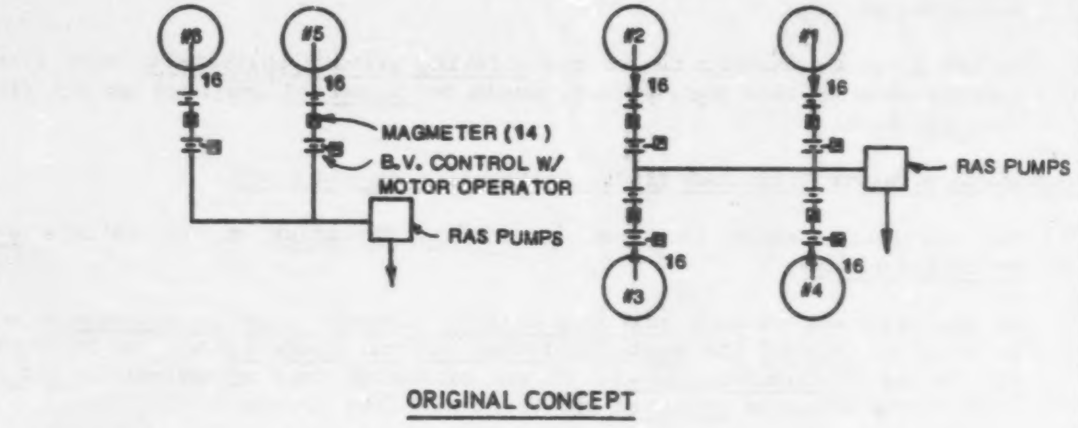
The original design balanced the sludge withdrawal rates from each clarifier by utilizing butterfly valves, and magnetic flow meters with motor operators for the butterfly valves. The sludge return rate to the aeration tank would be controlled by variable speed return activated sludge pumps.

The proposed concept would use an arrangement of telescoping valves and a headbox arrangement at each set of clarifiers. By adjusting all telescoping valves to the same elevation equal quantities of sludge would be withdrawn by hydraulic displacement from each clarifier. This rate would be adjustable by raising and lowering the telescoping valves. Each telescoping valve would be located in a separate compartment in the headbox and discharge over a V-notch weir so that the flow balance could be checked and adjusted as required. Figure 26 shows sketches of the original and proposed concepts.

Consolidate All Thickening at One Location

The design of the treatment facilities included a wastewater treatment plant at one site and a separate solids handling facility at another site. In the original design, the waste activated sludge was thickened in a dissolved air flotation unit on-site at the wastewater treatment plant before pumping to the solids handling plant. A 3-1/2% solids mixture of primary and thickened waste activated sludge was to be pumped to the solids handling plant.

The proposed concept recommended no thickening at the wastewater plant. Instead, a 1.8% solids mixture of primary and waste activated sludge would be pumped directly to the solids handling plant for thickening. This system


#6
#5
16
16
MAGMETER (14)
B.V. CONTROL W/
MOTOR OPERATOR
RAS PUMPS
#2
#1
16
16
RAS PUMPS
#3
16
#4
16
ORIGINAL CONCEPT

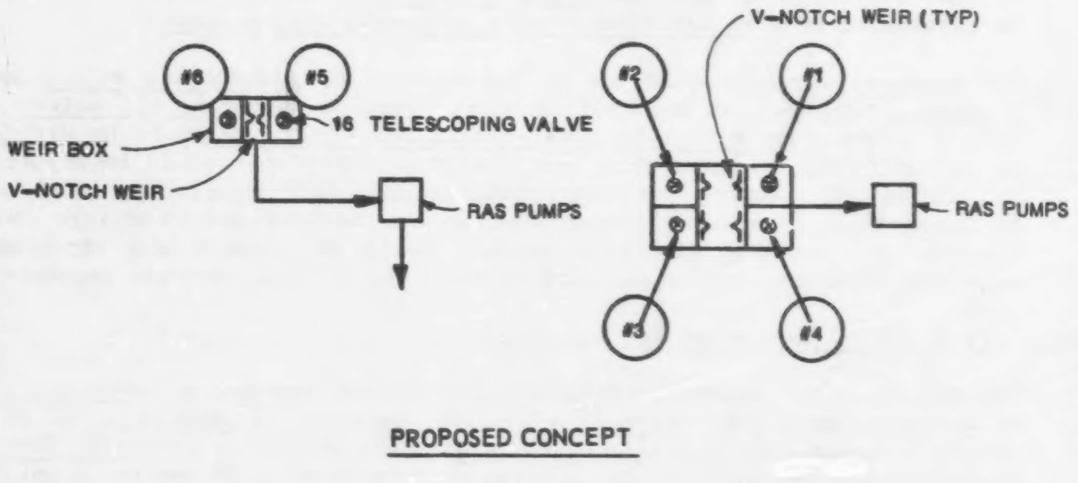

V-NOTCH WEIR (TYP)
#6
#5
16 TELESCOPING VALVE
WEIR BOX
V-NOTCH WEIR
RAS PUMPS
#2
#1
RAS PUMPS
#3
#4
PROPOSED CONCEPT

Figure 26. Replace control valves with telescoping valves.

eliminated the need for thickening at the wastewater treatment plant and consolidated all thickening at one single location.

Reduce Dissolved Air Flotation Size

In the original design, a single 700 sq ft dissolved air flotation (DAF) unit was provided at the facility. The unit was sized to accommodate peak flows of 2.3 times the average daily flows.

The proposed concept recommended reducing the size of the DAF thickener to 300 sq ft and providing a polymer feed system. The polymer feed system would be used only during peak flow conditions which were estimated to occur only about 5% of the time.

Eliminate Gravity Thickeners

The original concept provided gravity sludge thickeners for thickening primary sludge. Included with the thickeners was a thickened sludge holding tank and a pumping station.

The proposed concept eliminated the gravity thickeners and increased the capacity of the vacuum filters and also increased the size of the mix and holding tanks associated with the vacuum filters.

SLUDGE DEWATERING

Eliminate Covers from Sand Drying Beds

The original design concept included sand drying beds with covers.

The proposed concept suggested using the sand drying beds, but deleting the covers and thereby providing easier access to the beds. Drying time would be decreased during summer months but would increase during poor weather.

Add Heat Treatment for Sludge Dewatering

In the original concept, sludges from the primary and biological processes required chemicals in the dewatering process. The dewatered sludge was hauled to a remote incinerator.

In the proposed concept, heat treatment would be added to the dewatering process, thus increasing the percent solids and decreasing the amount of sludge that needed to be hauled to the remote incinerator.

Substitute Filter Presses for Vacuum Filters Prior to Incineration

In the original concept for the sludge handling system, vacuum filters were used to dewater the sludge prior to multiple hearth incineration. The original heat balance calculations used 20 to 25% moisture for vacuum filter dewatered sludge.

In the proposed concept, vacuum filters would be replaced by filter presses with a planned capability of producing 40% solids filter cake. The increased solids concentration would reduce or eliminate supplemental fuel required by the incinerator.

Eliminate Waste Activated Sludge Centrifuges

In the original concept centrifuges were used to thicken waste activated sludge prior to aerobic digestion. The system employed one unit with another standby centrifuge for either this operation or for thickening anaerobic primary sludge digested.

In the proposed concept no centrifuges were provided and the waste activated sludge was aerobically digested directly without thickening. The existing aerobic digestion facilities provided 6-1/2 days digestion under these operating conditions.

Use Conveyor Belt for Dewatered Sludge in Place of Pumps

The original concept indicated that dewatered sludge cake from a belt filter press was to be pumped to a truck loading facilities and then to be hauled to a landfill. The type of pump was unspecified.

Since the 25% to 35% moisture content of the dewatered sludge from the belt filter press would be very difficult to pump, the proposed concept recommended that the dewatered sludge be transported by a conveyor belt.

Use Waste Pickle Liquor in Lieu of Ferric Chloride

The original concept was to use a ferric chloride solution for one of the chemical conditioning agents.

The proposed concept would be to obtain free waste pickle liquor from a local steel mill.

Use Belt Filter Press with Polymer Conditioning in Lieu of Plate and Frame

The original concept utilized a plate and frame filter with ferric chloride for sludge dewatering.

The proposed concept used a belt filter press with polymer conditioning. The proposed concept simplifies operation and provides greater visibility of operating conditions.

Use Precast Concrete Walls for Sludge Drying Beds

The original concept used sand drying beds. Walls for the various sludge drying beds were to be constructed of cast-in-place reinforced concrete.

The proposal was to use precast concrete panels as a replacement for the original walls. The precast panels would be maintained in position by precast supports. A sketch of the proposed concept is shown in Figure 27.

Design Sludge Dry Beds for Mechanical Sludge Removal

Sludge disposal by liquid application on a golf course was planned as the primary method of disposal. When this primary method was seasonally unavailable, on-site sand drying beds were to be utilized. Because the sand drying beds were to be used only periodically, they were designed for manual sludge removal. The original design was for drain tile covered by a sand and gravel blanket.

Beds suitable for sludge removal by a front end loader were proposed. Asphalt was proposed over a base course, and the asphalt sloped to a six inch concrete drain tile running down the center of the bed. The proposed design would allow use of mechanical equipment. Sketches of the original and proposed concepts are shown in Figure 28.

Substitute Belt Filters for Vacuum Filters

Sludge dewatering was to be performed using vacuum filters, with sludge conditioning by lime and ferric chloride.

Replacement of the planned vacuum filters with belt filters was proposed. The conditioning chemicals would also be switched, from lime and ferric chloride to polymer.

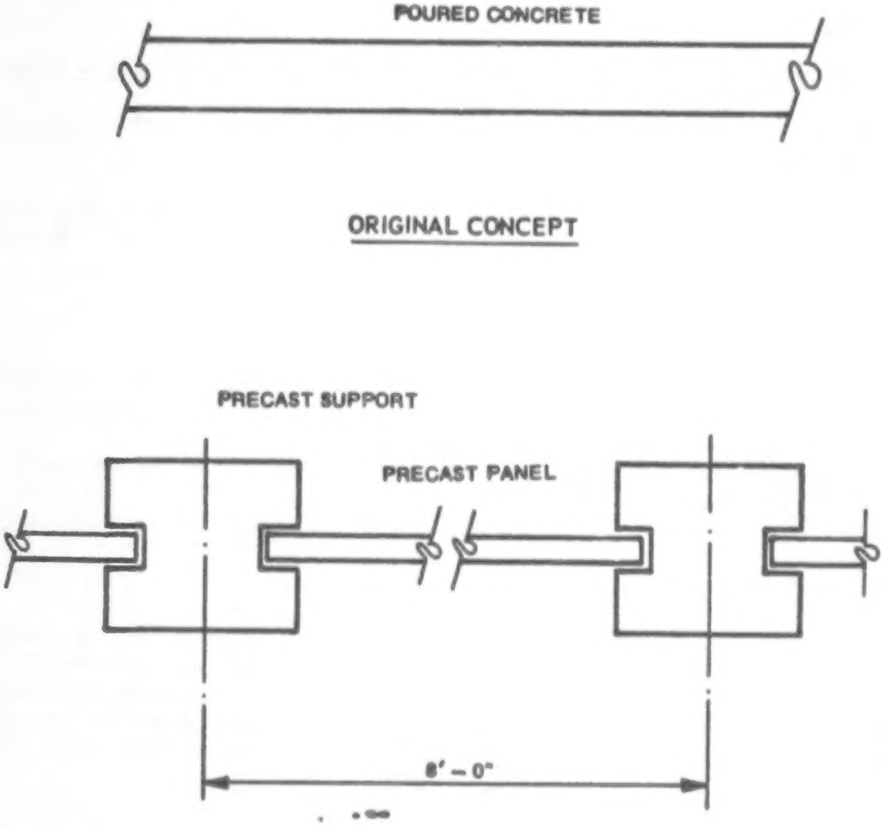
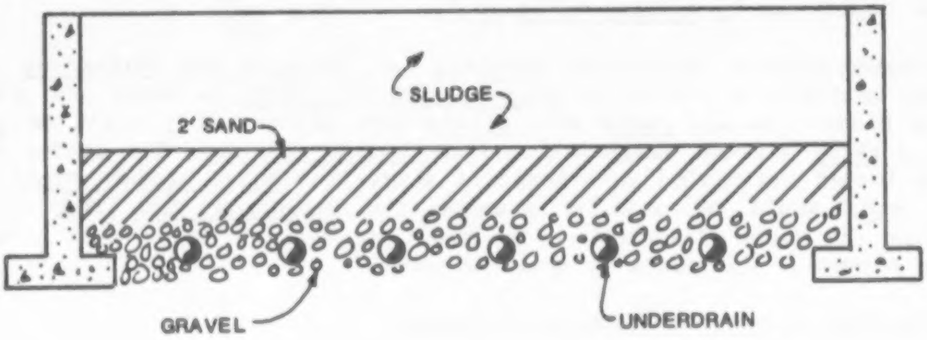
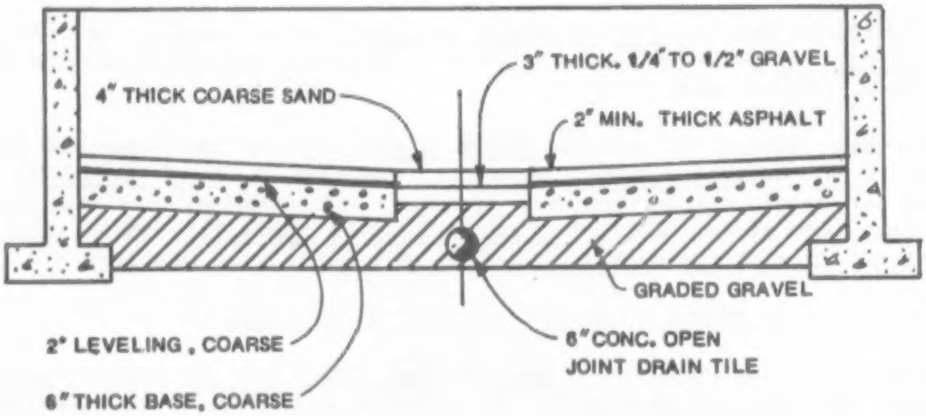

POURED CONCRETE
ORIGINAL CONCEPT
PRECAST SUPPORT
PRECAST PANEL
8' – 0"
PROPOSED CONCEPT

Figure 27. Use precast concrete walls.


SLUDGE
2' SAND
GRAVEL
UNDERDRAIN

ORIGINAL CONCEPT


3" THICK. 1/4" TO 1/2" GRAVEL
4" THICK COARSE SAND
2" MIN. THICK ASPHALT
GRADED GRAVEL
2" LEVELING, COARSE
6" CONC. OPEN JOINT DRAIN TILE
6" THICK BASE, COARSE

PROPOSED CONCEPT

Figure 28. Design sludge drying beds for mechanical equipment

SLUDGE STABILIZATION

Replace Anaerobic Digestion with Stabilization Lagoons

Originally, digestion and thickening was planned for sludge stabilization prior to placing it in a storage lagoon. Ultimate sludge disposal from the storage lagoon was by hauling to landfill.

The proposed concept recommended deleting the digestion and thickening systems and utilizing a series of anaerobic/aerobic ponds to store and stabilize the sludge. As the ponds were filled with sludge, they would be taken out of service and the sludge allowed to dewater and dry. The sludge could then be loaded and hauled to a landfill site. The lagoon sludge stabilization system would be used to provide the detention time required to stabilize the waste sludges from the plant as well as to provide adequate surface oxygen in the ponds to minimize odors.

Replace Gas Mixing System with Mechanical Mixers

Originally, the anaerobic digesters were provided with a gas mixing system which did not provide complete mixing.

It was recommended that a mechanical mixing system be used in place of the gas mixing system. The proposed system provided better mixing for the same horsepower input, required less maintenance, consumed less energy, and required less building space than the original design. A schematic of the original and proposed mixing systems are shown in Figure 29.

Reduce Digester Size

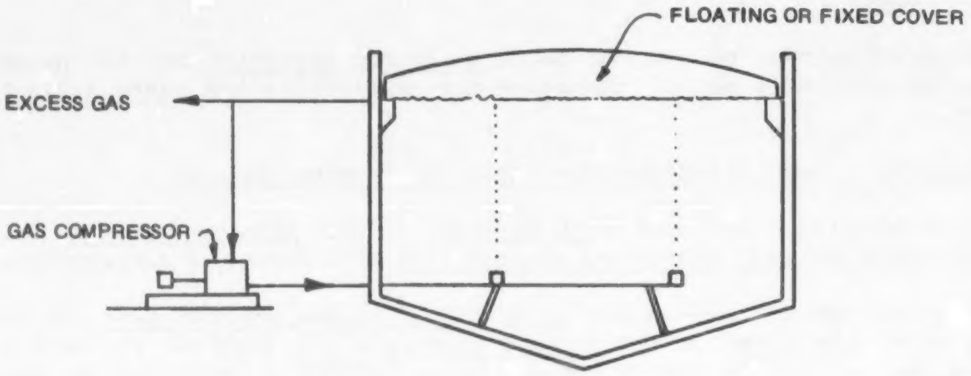
In the original design, two anaerobic digesters were sized to provide a 27-day detention time, which would give a 13-1/2 day detention time with one digester out of service.

The proposed concept recommended reducing the size of the digesters to provide a 14-day detention time, which corresponded to 0.11 lb VS/CF. This loading was considered well within the range of accepted time and loadings for a high rate digestion. Backup sludge holding capability was available at the plant if one of the digesters had to be taken out of service.

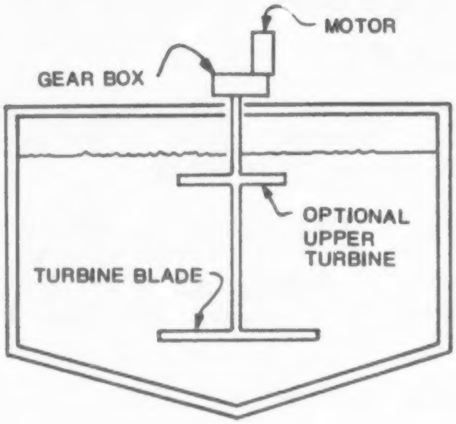
Delete Waste Activated Sludge Digestion and Dewater Directly

The original design combined primary sludge with waste activated sludge for treatment in anaerobic digesters. The combined anaerobic digested sludge was then dewatered on belt presses.

It was recommended that the waste activated sludge be dewatered on the belt presses prior to digestion. This proposal reduced the required size of the anaerobic digesters.


FLOATING OR FIXED COVER
EXCESS GAS
GAS COMPRESSOR

ORIGINAL CONCEPT


MOTOR
GEAR BOX
OPTIONAL
UPPER
TURBINE
TURBINE BLADE

PROPOSED CONCEPT

Figure 29. Mechanical mixing in anaerobic digesters.

Provide Aerobic Digestion for Secondary Sludge

The original design concept for sludge stabilization involved thickening the waste activated sludge from the secondary settling basin and then anaerobically digesting it.

The proposed concept recommended using anaerobic digestion for the primary sludge and providing aerobic digestion for stabilizing the waste activated sludge.

Movable Gas Holder Cover to Replace Fixed Cover on Primary Digester

The original design included a fixed cover on the primary digester and a high pressure (65 psi) sludge gas storage tank with three gas compressors.

The proposed concept recommended eliminating the gas storage tank and providing a movable cover on the primary digester. Gas required for digester heating and for use in the digester control buildings would be furnished from digester storage.

Insulate Anaerobic Digester Covers

Anaerobic digesters were designed with steel plate dome covers.

Addition of a 2-inch sprayed-on foam layer was proposed on top of the steel cover to provide further insulation to the digesters.

Digester Heating with Hydrogen Gas

The plant utilized on-site hypochlorite generation to produce hypochlorite for effluent disinfection. Hydrogen gas which was produced during the hypochlorite generation was planned to be wasted.

Use of the hydrogen gas to replace digester gas used for digester heating was proposed. Hydrogen gas would be used along with the digester gas in a boiler to heat hot water. The digester gas which was saved by the substitution could then be used in an engine generator to generate electrical power.

Earth Berms Around Anaerobic Digesters

Anaerobic digesters were designed with a 25 foot wall height, 10 feet below ground and 15 feet above ground. 16-inch thick concrete walls were used with no other form of insulation.

Use of earth berms to insulate the digesters was proposed to lower digester heating requirements and provide a more aesthetically pleasing plant site.

Eliminate Anaerobic Digester Supernatant Tank

The original concept was to construct a holding tank to store anaerobic digester supernatant and to feed it back to the headworks at a controlled rate.

In the proposed concept the supernatant holding tank was deleted, assuming that the secondary digester could be considered as a holding tank.

Eliminate Aerobic Digester and Use Existing Anaerobic Digesters

In the original concept, centrifuges were to be used to thicken waste activated sludge. Existing primary clarifiers and aeration basins were to be converted to aerobic digesters for digestion of the centrifuge thickened WAS. Primary sludge was to be anaerobically digested in existing anaerobic digesters.

In the proposed concept the same centrifuge thickening scheme was to be retained, but the existing anaerobic digestion capacity was to be used for both the primary sludge and the centrifuge thickened WAS.

Substitute Boilers in Place of Supplemental Solar Panels

The original concept utilized a solar panel hot water system to furnish supplemental heat to the digesters.

The proposed concept would provide more reliable conventional oil fired boilers and completely eliminate the solar panels.

Include Conical Portion of Anaerobic Digester in Effective Volume

Anaerobic digesters were 105-feet in diameter and had a bottom slope of 1:1. Detention time in the anaerobic digesters was calculated using only the cylindrical portion of the digester, and did not count the conical portion.

The proposed concept recommended that the conical portion be included as a usable portion of the digester capacity and in calculating the detention time of sludge in the digester. This would allow the digester diameter to be reduced from 105 feet to 85 feet.

Substitute Mechanical Aeration for Diffused Aeration in Aerobic Digesters

A activated sludge plant was to aerobically digest thickened primary and waste activated sludge. The original concept was to use diffused aeration to supply air to the aerobic digesters.

The proposal was to utilize surface mechanical aerators to replace the diffused aeration system.

Reduce Number of Digesters and Use Floating Covers

The plant was to be designed using three anaerobic digesters, each 90 feet in diameter and 24 feet SWD. Two feet of freeboard was provided, and fixed concrete covers supported on concrete were used on each digester. Gas storage at 50 psig was provided in a gas storage sphere for 1 day of gas production at 50 psig.

Reduction of the number of digesters from 3 to 2 was proposed, along with elimination of the gas storage sphere. Gas storage was proposed to be accomplished by the addition of steel floating gas holding covers for both digesters. The new digesters would be 110 feet in diameter and have 24 feet of SWD.

Eliminate Cranes from Anaerobic Digester Roofs

Three 95 foot diameter anaerobic digestors with fixed concrete covers were utilized for sludge stabilization. Heating of the digesters was accomplished using vertical internal heat exchangers placed into the digesters through the roof. Each digester was provided with a roof top crane for removal of the heat exchangers when required.

The proposal was for elimination of the permanent cranes, and use of rental cranes or use of temporary false work when removal of the heat exchangers was required. Removal was estimated to be once every five years or less, based on past experience.

Substitute High-Rate Anaerobic Digesters for Low-Rate

The original concept used two gravity thickeners for a combination of primary and rotating biological contactor secondary sludge. The thickened sludge was to be anaerobically digested using two stage digestion. Two primary digesters provided a 35 day detention time and they were equipped with floating covers. Secondary digesters were equipped with fixed covers. The four digesters and the two thickeners were clustered around a central building.

The proposed change was to construct three high rate digesters. The total detention time would be 14 days with two of the digesters in operation and the third utilized as a holding tank. The three digesters and two gravity thickeners would be clustered around an enclosed pentagon shaped sludge pump station and boiler room.

Reduce the Number of Digester Gas Mixing Compressors

The original design called for 5 gas compressors. Each primary digester would have one operational and one standby compressor and a fifth compressor was to be used for the two secondary digesters.

In the proposed design, the secondary digester mixing compressor and one of the standby compressors for the primary digesters were eliminated. When secondary digester mixing was required, it was proposed to use the standby compressor for that purpose.

SLUDGE DISPOSAL

Haul Liquid Sludge and Eliminate all Sludge Treatment

The original design concept included aerobic digestion plus sand drying beds for the first five years of plant operation. Phases II & III of the treatment facility, which were to occur sometime after the first five years, included aerobic digestion plus vacuum filtration.

The proposed concept recommended hauling liquid waste activated sludge and primary sludge directly to a treatment plant 20 miles away and completely eliminating all sludge treatment.

Eliminate Sludge Storage Tank

The regional solids handling facility included a holding tank to receive sludge which was hauled from other treatment facilities. A pump station was provided to transfer sludge from the holding tank directly to the digesters.

The proposed concept recommended pumping sludge directly from the trucks to the anaerobic digesters, eliminating the need for the sludge storage tank since the daily volume of sludge to be hauled in was only a very small percentage of the total sludge in the digesters.

Use Pipe Line Rather Than Trucks to Transport Sludge

In the original concept the digested sludge was hauled using 5500 gallon trucks to an ultimate disposal site approximately five miles from the treatment plant site. About 11 truck loads a day were required at design capacity of the plant.

In the proposed concept an 18-inch pipeline was used to transport a 4% solids sludge to the ultimate disposal site.

Use Throttling Vanes in Place of Variable Speed Drives on Induced Draft Fans

The original concept proposed to use four induced draft fans on sludge incinerators. The fans were proposed to have variable speed drives to provide adjustable air inputs.

In the proposed concept two ID fans were used with throttling ID fan inlet vanes rather than variable speed drives.

Preheat Incinerator Combustion Air

The original concept utilized conventional combustion air injection without preheating.

The proposed concept would install a type 304 stainless steel heat exchanger in the bridging between the incinerator and scrubber thereby preheating the combustion air to 800 degrees Fahrenheit prior to injecting air into the furnace.

Eliminate Incinerator Ash Storage Basin

An impingement type scrubber was planned to be used on a sludge incinerator, with the flow from the scrubber passing to a storage basin. After settling, water from the basin would be returned to the scrubber system.

Use of a cyclone separator was proposed as a substitute for the ash storage basin. Water from the impingement scrubber would be pumped by a booster pump to the cyclone separator, and after separation the clarified water would be recycled and reused in the impingement scrubber. Ash would be disposed of identically in either scheme.

Eliminate Sludge Storage Bins

The original design included sludge storage bins to hold sludge after being removed the sludge drying beds.

The proposed concept recommended eliminating the sludge storage bins and hauling the sludge directly to a landfill

CHAPTER 4

EARTHWORK

Use Reclaimed Rock From on Site Excavation for Construction of Breakwater

The original concept proposed sheet steel piling for a 700 foot long cofferdam at an existing lagoon.

The proposed concept would utilize rock, excavated from another part of the construction site, to cover the surface of the cofferdam. Additional material would be required to make the cofferdam impervious.

Reduce Final Grade

This project was to be constructed in a swampy area, and costly fill material would have been required to raise the entire site.

The proposal was to lower the entire site elevation (not the structures) by 1'. This would make the entire site more prone to flooding, but would not make the treatment facilities themselves more suscepible to flood damage. Some redesign would be necessary to implement the proposal.

Reorient Plant and Change Site Grading to Eliminate Handrails

In the original concept, on-site influent piping was conveyed through several hundred feet of pipe tunnel before reaching the influent structure. Also, finished grades were 6- to 12-inches below tank tops, and aluminum handrails were used around each of the basins.

The proposed concept recommended reorientation of the plant to put the influent structure closer to the location where the influent sewer entered the plant site. This reorientation also eliminated "back and forth" conveyance of flows on the plant site. Another modification was to lower the finished grade 30- to 36-inches below the top of the various structures, thereby eliminating the need for the handrails around the basins.

Eliminate Retaining Wall and Regrade

The original concept proposed a retaining wall to be located between a process building and the roadway.

The proposed concept would eliminate the retaining wall and regrade the slope.

Use Precast Panels Instead of Retaining Wall

In the original concept a retaining wall was used to support an earth embankment. Construction was to be a standard cantilevered wall with backfill behind the wall and a lower finish grade in front of the wall. Along the same area sheet piling was to be placed during construction and then later cut off and replaced by the retaining wall.

In the proposed concept the steel piling would remain in place and precast concrete panels are set behind the piling flanges to form a retaining wall. Figure 30 shows sketches of the original and proposed concepts.

Use Open Cut Excavation in Lieu of Coffer Dam Construction

A large interceptor pumping station was planned to be constructed using pilings, bracing, excavation, and deep well dewatering. Excavation would be using a clamshell bucket.

The proposed concept recommended elimination of the complex bracing, pilings and dewatering by using open cut excavation.

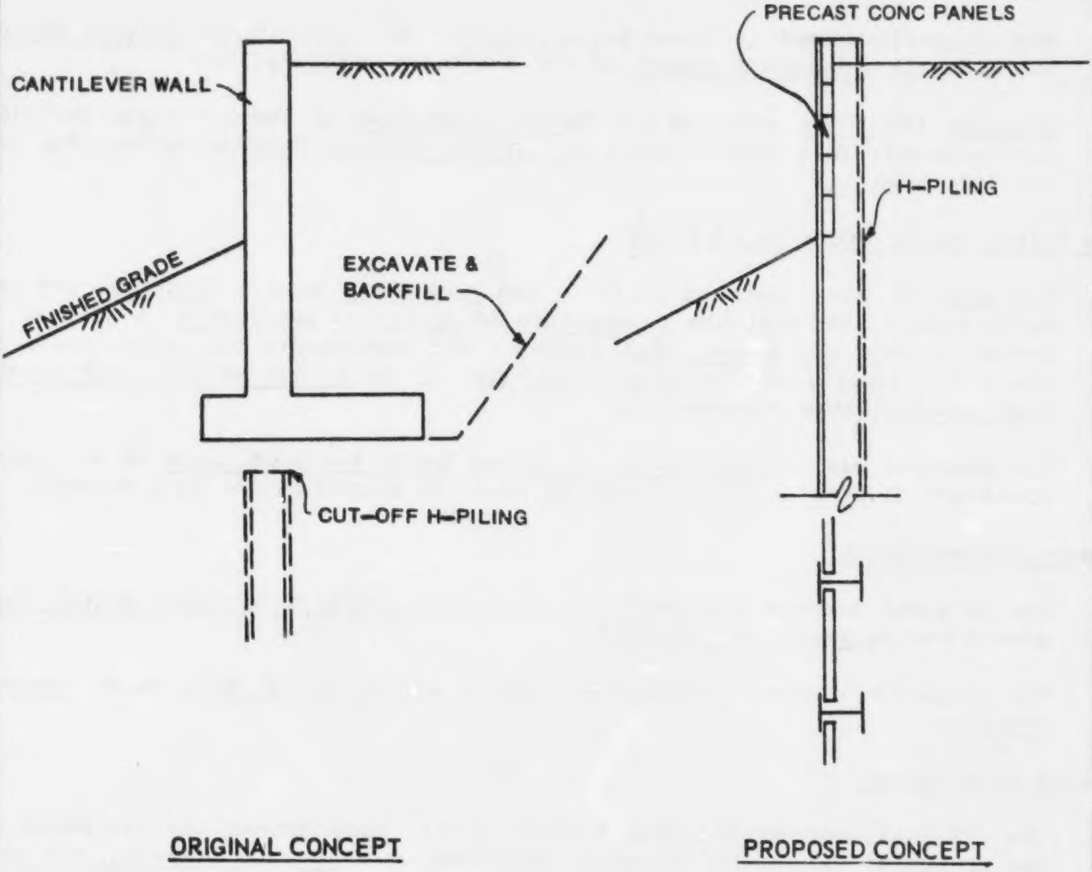

CANTILEVER WALL
FINISHED GRADE
EXCAVATE & BACKFILL
CUT-OFF H-PILING
ORIGINAL CONCEPT
PRECAST CONC PANELS
H-PILING
PROPOSED CONCEPT

Figure 30. Replace retaining wall with precast panels in H-piles.

ROADS

Use Narrower Entrance Road

The original concept used two 24-foot divided entrance roads with complete curbing and gutters.

It was proposed to eliminate one of the divided roads, and eliminated the curb and gutter from the remaining road.

Delete Roads Required for Future Expansions

The original concept included roads required for not only the initial phase, but also all subsequent phases of the treatment facility.

Deleting the roads required for future expansions of the treatment facility was proposed. This change would not affect traffic flow or access for the initial phase.

Use Filter Fabric Under Paved Areas

The site for the treatment facility had previously been a landfill, and the soils report indicated the probability of continued settlement. A minimum of 2-foot of sand and gravel base material was recommended for plant roads by the soils report, and in some locations, up to 4-foot of sand and gravel base material were recommended.

The proposed was to excavate to 20-inches below finished grade of all paved areas and to install fabric material prior to spreading the base material.

Reduce Roadway Width

The original concept provided a 20 foot wide paved and curved access road around the perimeter of the plant.

The proposed concept reduces the paved width to 12 feet with one-way traffic.

Change Road Paving

The original concept proposed a paved access road around the perimeter of the treatment plant. The pavement consisted of a 10 inch subbase, six inch processed aggregate base, and three inch paved road section.

In the proposed concept oil treated gravel would be used on the access roads around the plant perimeter. The gravel base would be 12 inches of crushed gravel.

Revise Site Roadways and Reduce Roadway Width

In the original concept an extensive network of various width of roadways, multiple parking areas, and numerous paved turn around or access areas for the various buildings of the treatment units were used.

In the proposed concept roadway widths were reduced from 24 feet to 18 feet, which was considered ample for the low speed travel which would be required at the plant site. The parking areas were also revised and reduced, but still remained functional.

PIPING

Simplify Return Activated Sludge Flow Balancing Scheme

In the original concept, return activated sludge (RAS) flow would be split by an instrumentation based ratio scheme utilizing flow meters and throttling valves to determine the relative proportions of sludge to each aeration basin. The ratio to be utilized would be entered by the operator. Normally, 1/2 - 1/2 for the first stage aeration and 1/3 - 1/3 - 1/3 for the second stage aeration.

In the proposed concept, RAS flow would be routed to the aeration basin influent splitter boxes and split with the influent, thus eliminating the complicated instrumentation system. Figure 31 shows schematics of the original and proposed schemes.

Eliminate Pipe Gallery

The original design proposed air pipe gallery along the end of the aeration tank.

The proposed alternative was to eliminate the gallery and to either bury the pipes or to support them from exterior walls above grade.

Modify Scum Handling Systems

Scum from secondary clarifiers and backwash water from tertiary filtration facilities was to be transported to a reclaimed water clarifier. Settled material from the reclaimed water clarifier would then go to a waste sludge pump station, and scum off the top of the clarifier would be pumped to the Sludge Disposal area for further concentration and incineration. All lines which were to carry scum or the scum/backwash were lined to prevent build-up of scum in the pipe.

The proposal was based upon both eliminating the dilution of scum with filter backwash water and then reconcentrating the scum in the reclaimed water clarifier, and eliminating as much piping as possible, particularly lined pipe. Based on these two concepts, the following changes were proposed: eliminating the reclaimed water clarifier, pneumatically ejecting scum from the final clarifier directly to the Sludge Disposal Area, eliminating the separate lined pipeline for scum/backwash, and conveying backwash water directly to the plant drain through an unlined pipe.

Use PVC to Replace Ductile Iron Pipe

Potable and non-potable water systems between 3-inch and 8-inch were originally designed to be of ductile iron pipe.

Class 160 PVC (ASTM D2241) was proposed as a replacement for the ductile iron pipe.

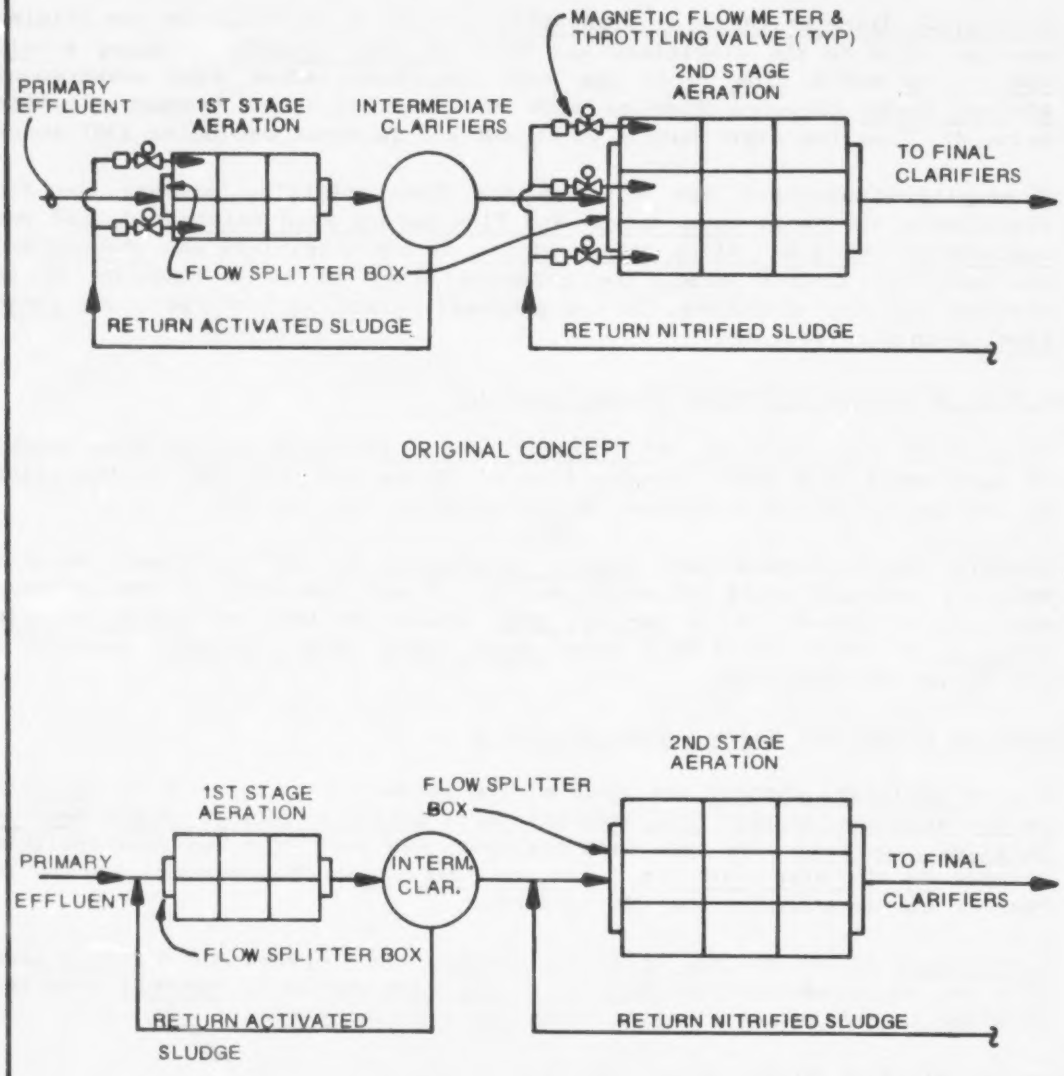

MAGNETIC FLOW METER & THROTTLING VALVE (TYP)
PRIMARY EFFLUENT
1ST STAGE AERATION
INTERMEDIATE CLARIFIERS
2ND STAGE AERATION
TO FINAL CLARIFIERS
FLOW SPLITTER BOX
RETURN ACTIVATED SLUDGE
RETURN NITRIFIED SLUDGE
ORIGINAL CONCEPT
2ND STAGE AERATION
1ST STAGE AERATION
FLOW SPLITTER BOX
PRIMARY EFFLUENT
INTERM. CLAR.
TO FINAL CLARIFIERS
FLOW SPLITTER BOX
RETURN ACTIVATED SLUDGE
RETURN NITRIFIED SLUDGE
PROPOSED CONCEPT

Figure 31. Simplify return activated sludge flow balancing scheme.

Simplify Secondary Clarifier Flow Distribution and Piping

Five equal diameter circular clarifiers were to be utilized in the original concept. Flow to the clarifiers was to be divided equally by using a knive gate valve and a flow meter for each clarifier. After flow measurement, 42-inch pipes conveyed flow to each clarifier with the nearest clarifier being 45' from the distribution vault and the furthest one being 230' away.

A simplified approach was proposed for flow splitting between the five clarifiers. The knife gate valves and flow meters were eliminated, and were replaced by weirs and slide gates. Piping to the clarifiers was changed from the original 42-inch size, the proposed sizes to be a function of the distance to each clarifier. In the proposal, distribution pipe sizes ranged from 36-inch to 48-inch.

Reduce Size of Return Activated Sludge Pipeline

Originally, 1200 feet of 36" diameter return activated sludge line capable of handling a peak return sludge flow of 15 MGD was included in the plans. An average operating condition for the pipeline was 7.5 mgd.

Concern was expressed over solids deposition in the pipeline. Scouring velocity probably would not occur at the 7.5 mgd flow rate in the 36" pipe. Analysis indicated that a 24-inch pipe should be used to create scouring velocity at the 7.5 mgd flow rate. Power costs were increased somewhat by use of the smaller pipe.

Splitting of Return and Waste Activated Sludge

A flow splitting chamber was used at the secondary clarifiers to split the return activated sludge (RAS) and the waste activated sludge (WAS). Separate parallel pipelines were then used for about 800 feet from the flow splitting chamber to the dissolved air flotation thickeners (WAS piping) and to the head of the aeration basins (RAS piping).

Elimination of the RAS/WAS splitting chamber was proposed and a single pipeline was to be used to the DAF units. RAS flow was to be metered from this pipeline to the aeration basins using two metering pumps.

Replace Tunnels With Buried Structural Slab

The plant under consideration was to be constructed on the site which had previously been a sanitary landfill. This necessitated the use of piling to support the tunnels which provided access between the treatment processes and in which piping was located. Because of the possibility of methane gas seeping into the tunnels, a positive ventilation system and a hazard-warning system were required.

The proposed concept recommended use of a buried structural slab in place of the tunnels. Piling would still be required because of high groundwater and poor subsurface conditions, and the structural slab would have to be attached to the piling. The proposal would eliminate heating, lighting, ventilation and drainage for the tunnels.

Substitute Steel for Ductile Iron Inside Piping

The original concept used ductile iron pipe with flanged fittings on all process scum, sludge, air, potable water and non-potable water piping.

Standard steel piping with welded fittings and sleeve type joints was proposed as a substitute.

Relocate Influent Force Main, Outfall, and 36" Storm Drain Into a Common Trench

In this study, the treatment processes and plant layout could not be changed, but relocation of the influent force main, the outfall, and an on-site storm drain was identified as an area of cost savings. The plant site was crossed completely or partially by an influent force main, the plant outfall, and a storm drain. Each of these facilities was to be installed separately in its own trench.

The proposed concept recommended relocation of these facilities so that use of a common trench was possible for much of their length. The original and proposed layouts are shown in Figure 32.

Use Class IV Reinforced Concrete Pipe for Final Effluent Piping

The original concept proposes to use prestressed concrete cylinder pipe for the effluent piping.

In the proposed concept, Class IV reinforced concrete pipe would be substituted for the original concept.

Revise Air Piping Material

In the proposed concept all air piping was to be stainless steel whether it is buried or exposed to the atmosphere.

In the proposed concept the exposed outside piping would remain stainless steel but all other piping would be carbon steel or cast iron.

Use Open Channel for Storm Flow Instead of Storm Drain

The original concept calls for the construction of two 60 inch storm drains to intercept an existing storm drain.

In the proposed concept, the two 60-inch pipes would be used only where open channel flow was not possible. An open channel would be used for the remainder of the diversion.

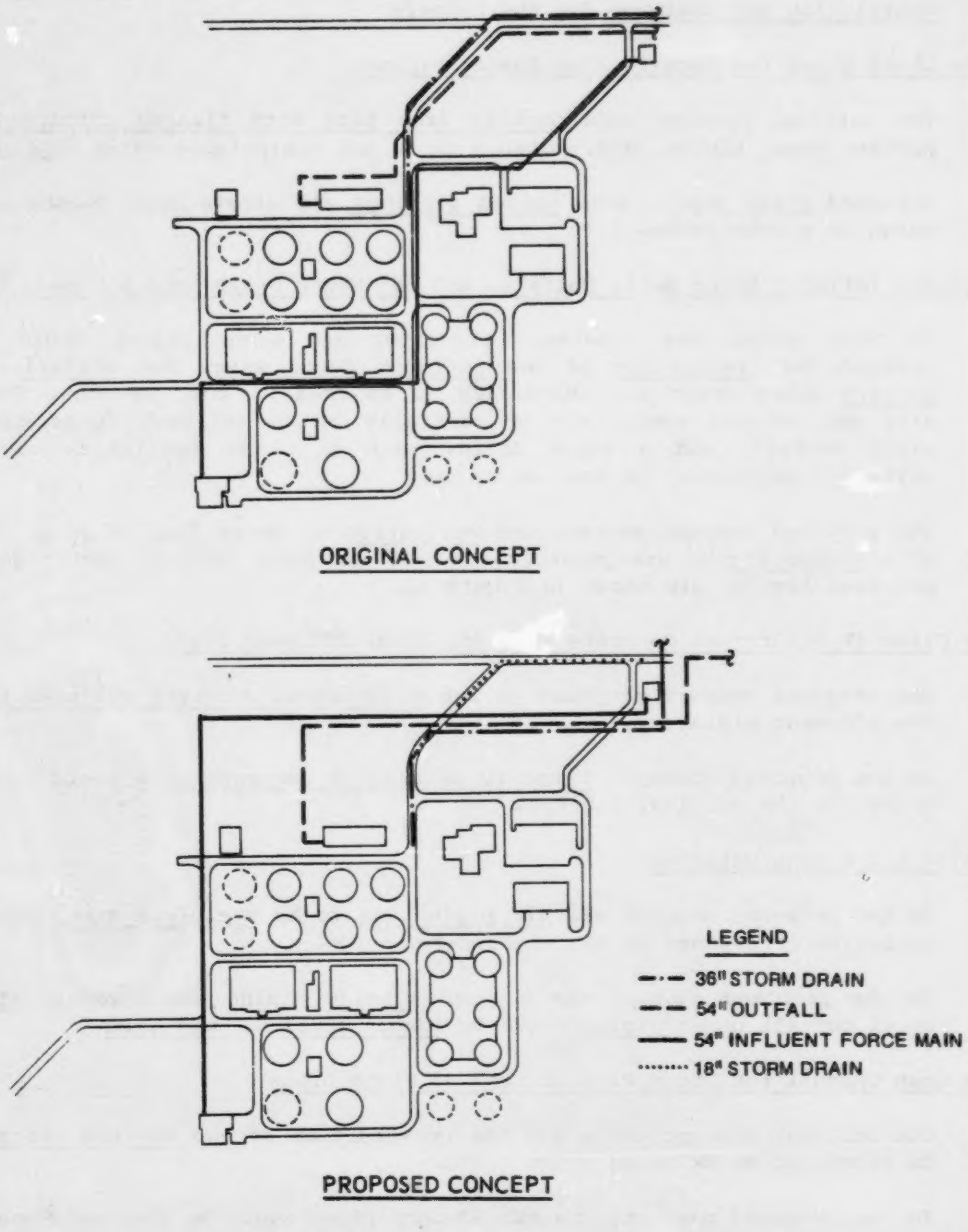

ORIGINAL CONCEPT
PROPOSED CONCEPT
LEGEND
36" STORM DRAIN
54" OUTFALL
54" INFLUENT FORCE MAIN
18" STORM DRAIN

Figure 32. Reduce length of yard piping.

Delete Pipe and Gates to Drain Head End of Aeration Tank

Aeration basins in the plant were divided into four stages to allow some of the aeration basin tankage to be taken out of service in the winter months. Gates were provided at both ends of the aeration basins, even though only the later stages of the aeration basins would be taken out of service in the winter.

In the proposed concept all drainage would be removed from the tail end of the basin, eliminating approximately half of the interconnecting pipe and four sluice gates. A sketch showing the deleted piping is in Figure 33.

Relocate Splitter Box for New Secondary Clarifiers

Two new secondary clarifiers were to be added to a plant which had four existing clarifiers. Flow to the existing clarifiers was split by a four-way splitter box. The original concept called for the modification of this four-way splitter box into a six-way splitter box which would serve both existing and new clarifiers.

Because the new clarifiers were not in the same area as the existing clarifiers and because the pipe to the existing four-way splitter box passed adjacent to the new clarifiers, it was proposed that the flow for the new clarifiers be split out ahead of the existing four-way splitter box. Therefore, the new splitter box would split the flow for the two new clarifiers, and the flow to the existing four-way splitter box. The proposal resulted in a savings of piping, and eliminated modification of the existing splitter box. Sketches of the original and proposed concepts are shown in Figure 34.

Relocate Sludge Pumping Station More Centrally to Multiple Clarifiers

Separate waste sludge and return sludge lines were used from six clarifiers to the sludge pumping station. Due to the layout of the plant, some of these pipes were relatively long, and plugging was a potential problem. Horizontal centrifugal pumps were planned to be used for sludge pumping.

The proposed concept suggested eliminating the long pipe runs by locating a sludge pumping station between each bank of two clarifiers. Vertical mixed flow pumps were proposed for the waste activated sludge, and vertical centrifugal pumps were proposed for the return activated sludge.

Combine Mixed Liquor Suspended Solids Piping

In the original concept, three mixed liquor suspended solids lines were required. One line was to two existing intermediate clarifiers and the two remaining lines were to two new intermediate clarifiers.

In the proposed concept, the MLSS piping was combined to the greatest possible extent. Figure 35 shows a sketch of the original and proposed concepts.

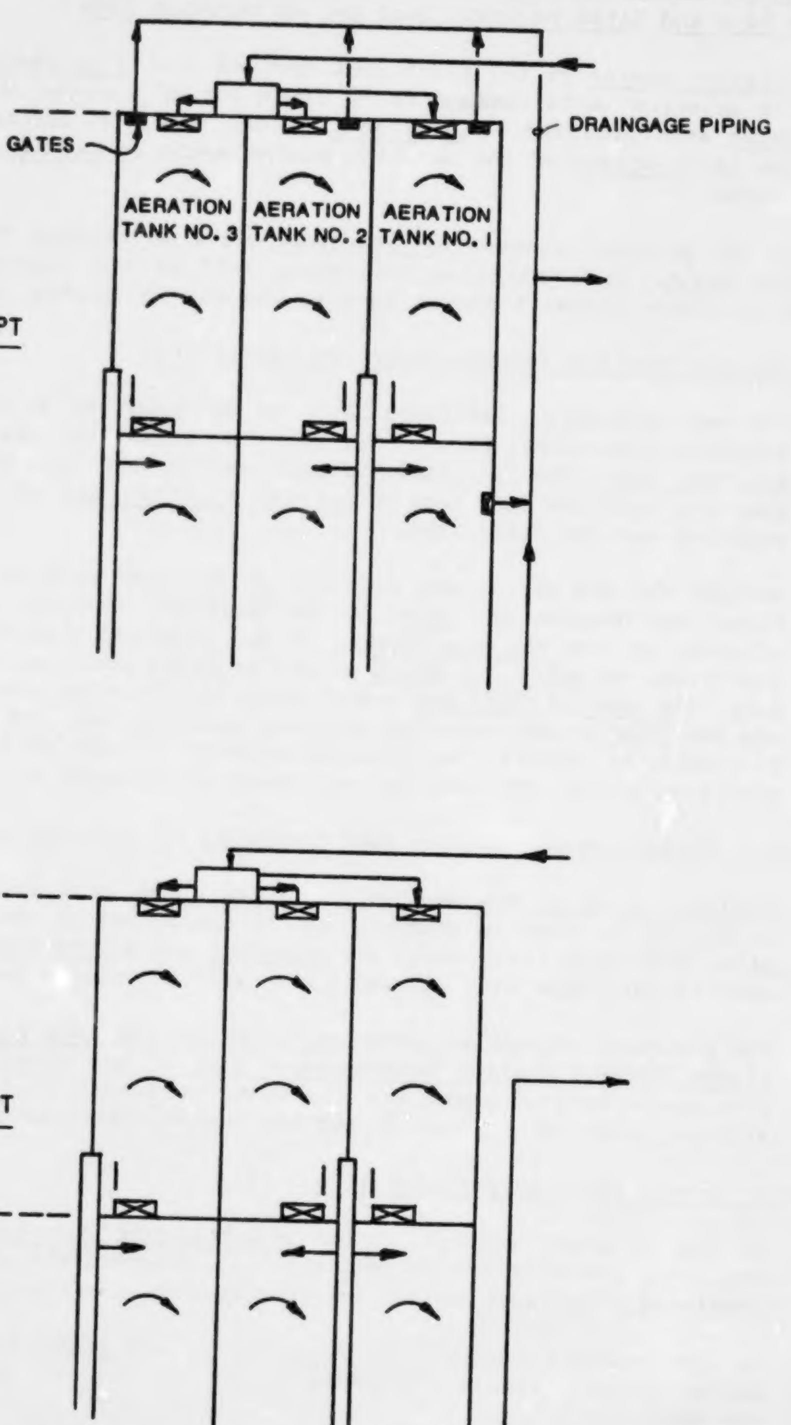

GATES
DRAINAGE PIPING
AERATION TANK NO. 3
AERATION TANK NO. 2
AERATION TANK NO. 1
ORIGINAL CONCEPT
PROPOSED CONCEPT

Figure 33. Delete drain pipes and gates from head end of aeration basin.

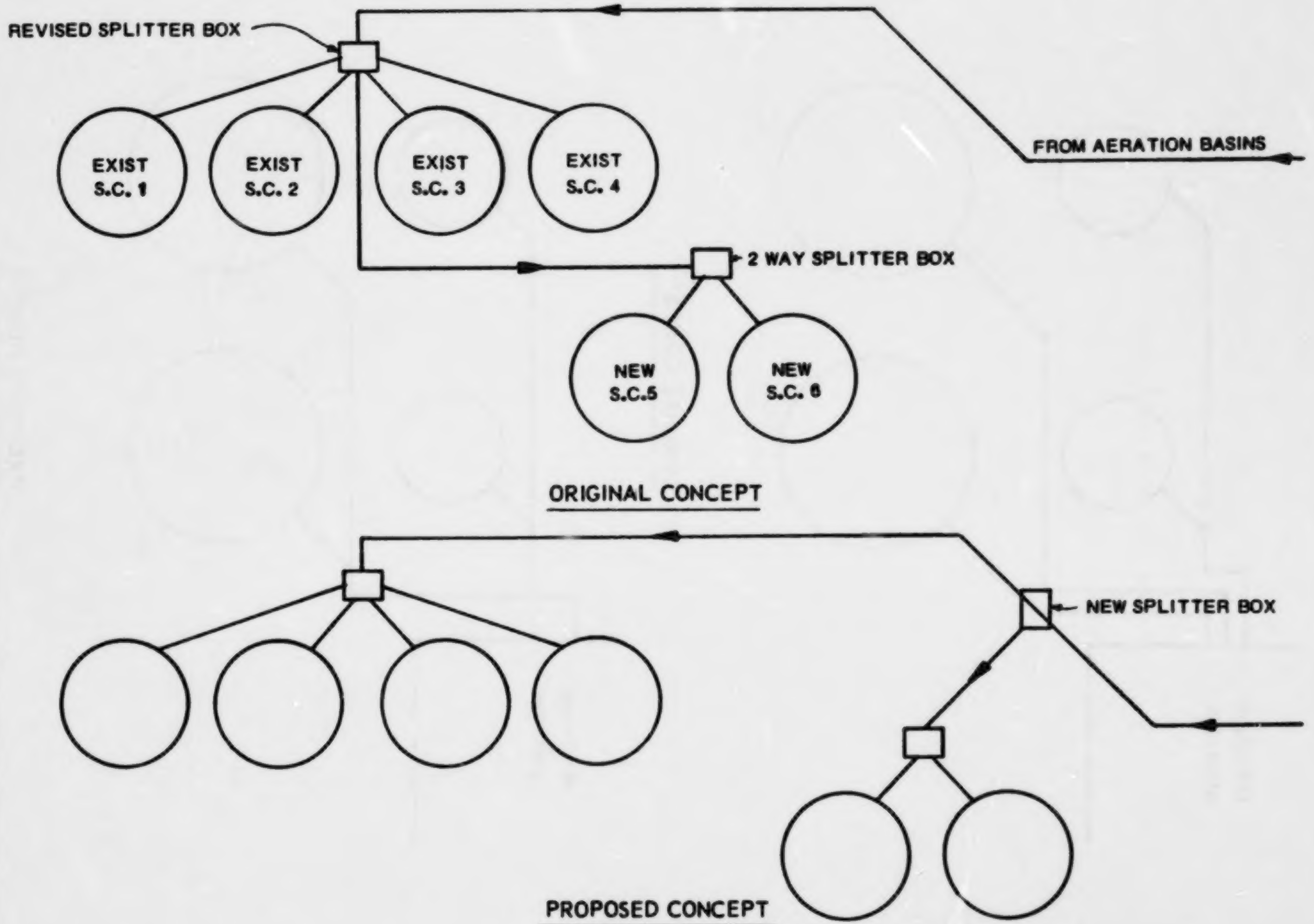

REVISED SPLITTER BOX
EXIST S.C. 1
EXIST S.C. 2
EXIST S.C. 3
EXIST S.C. 4
FROM AERATION BASINS
2 WAY SPLITTER BOX
NEW S.C.5
NEW S.C. 6
ORIGINAL CONCEPT
NEW SPLITTER BOX
PROPOSED CONCEPT

Figure 34. Relocate flow splitter box.

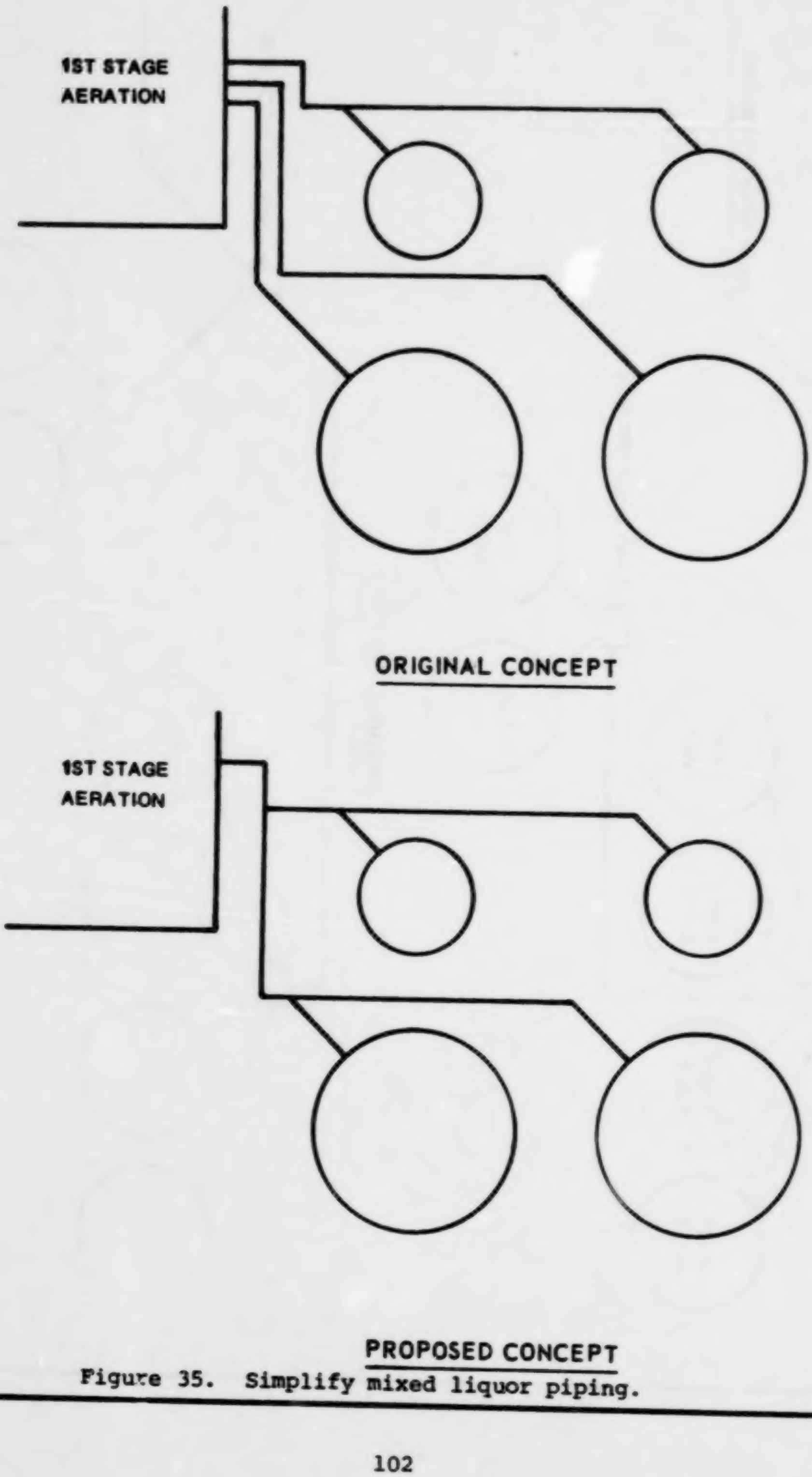

1ST STAGE
AERATION
ORIGINAL CONCEPT
1ST STAGE
AERATION
PROPOSED CONCEPT

Figure 35. Simplify mixed liquor piping.

Substitute Alternative Materials for Large Diameter Stainless Steel Air Headers

The original design concept included using stainless steel air piping for areas above the primary effluent and mixed liquor channels, and for piping in the runs from the blowers to the aeration basin complex.

By enclosing the mixed liquor in a conduit, the air headers on the edge of the aeration basin could be supported on top of the mixed liquor conduit and would not be exposed to the mixed liquor. Pipe material could then be changed from stainless steel to some other material such as welded steel pipe. Where corrosive conditions did not exist, use of fusion-bonded epoxy-coated and lined carbon steel pipe was recommended.

Eliminate Mixed Liquor Distribution Piping

The initial design used piping to distribute mixed liquor to the aeration basins.

It was recommended that the mixed liquor distribution piping be eliminated and adjustable weirs off the center channel be used for mixed liquor flow control.

Revise Chlorine Contact Tank Piping

Large diameter buried valves and fittings were originally proposed for the chlorine contact tank piping.

Elimination of most of the buried valves and fittings were proposed by adding a cast-in-place inlet box and distribution trough. Valve functions were accomplished using fabricated slide gates.

Combine Supply and Return Flow in Flow Equalization Basin

The original design concept used a flow equalization basin, with the basin divided into four sub-basins. Each of these sub-basins had separate inlet and outlet pipes.

The proposed concept recommended that the basin be served by a single pipeline which would both fill and empty the basins.

Bury Pipe Instead of Digging Trenches for Digester Piping

The original design concept placed sludge piping in a concrete trench between the solids handling control building and the digesters.

The proposed concept recommended burying the piping instead of providing the pipe trenches.

Place the Blower Discharge Pipes Above Ground

In the original design, all of the blower discharge pipes were placed in concrete trenches below grade.

It was recommended that the discharge pipes be placed above ground to provide better access and ease of maintenance.

Route Return Flows to Primary Clarifiers Rather Than To Headworks

The plant drain, thickener, supernatant, and filter press filtrate were piped back to the headworks of the plant in the original design.

The proposed concept recommended routing the return flow piping to the head of the primary clarifiers rather than to the plant headworks. Plant flow monitoring was improved because returned flows would not distort influent flow measurement at the Parshall flumes.

Eliminate Air Pipe Insulation

In the original design, the air blower discharge piping was provided with insulation.

The proposed concept recommended eliminating the insulation from the discharge pipe because the pipe was not considered to be hot enough to be a safety hazard.

Piping to Secondary Clarifiers

Flow from rotating biological contactor secondary treatment was to be conveyed by four separate pipes to the four secondary clarifiers.

Use of a single pipeline to a splitter box in the center of the four clarifiers was proposed. Slide gates would be used in the splitter box to proportion flows between the clarifiers. Figure 36 presents sketches of both the original and the proposed concepts.

Increase Size of Return and Waste Activated Sludge

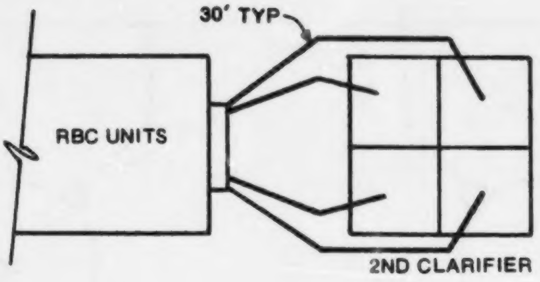
A pure-oxygen activated sludge plant was designed with the return activated sludge and waste activated sludge piping sized for a 2% solids concentration, based upon on-site pilot studies.

The proposal recommended re-sized sludge piping based upon a solids content of 1% rather than 2%. One percent solids was cited as being more representative of operating full-scale pure oxygen plants.

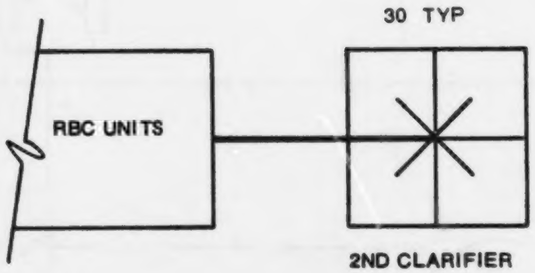
Revise Scum Piping

In the original concept, separate scum piping was used between two intermediate clarifiers and the pump station which housed the scum pumps. Two scum pumps were provided for each clarifier.

The proposed concept recommended using a common scum line and common scum pumps. Sketches of the original and proposed concepts are shown in Figure 37.


30' TYP
RBC UNITS
2ND CLARIFIER

ORIGINAL CONCEPT


30 TYP
RBC UNITS
2ND CLARIFIER

PROPOSED CONCEPT

Figure 36. Use single mixed liquor pipe to secondary clarifiers.

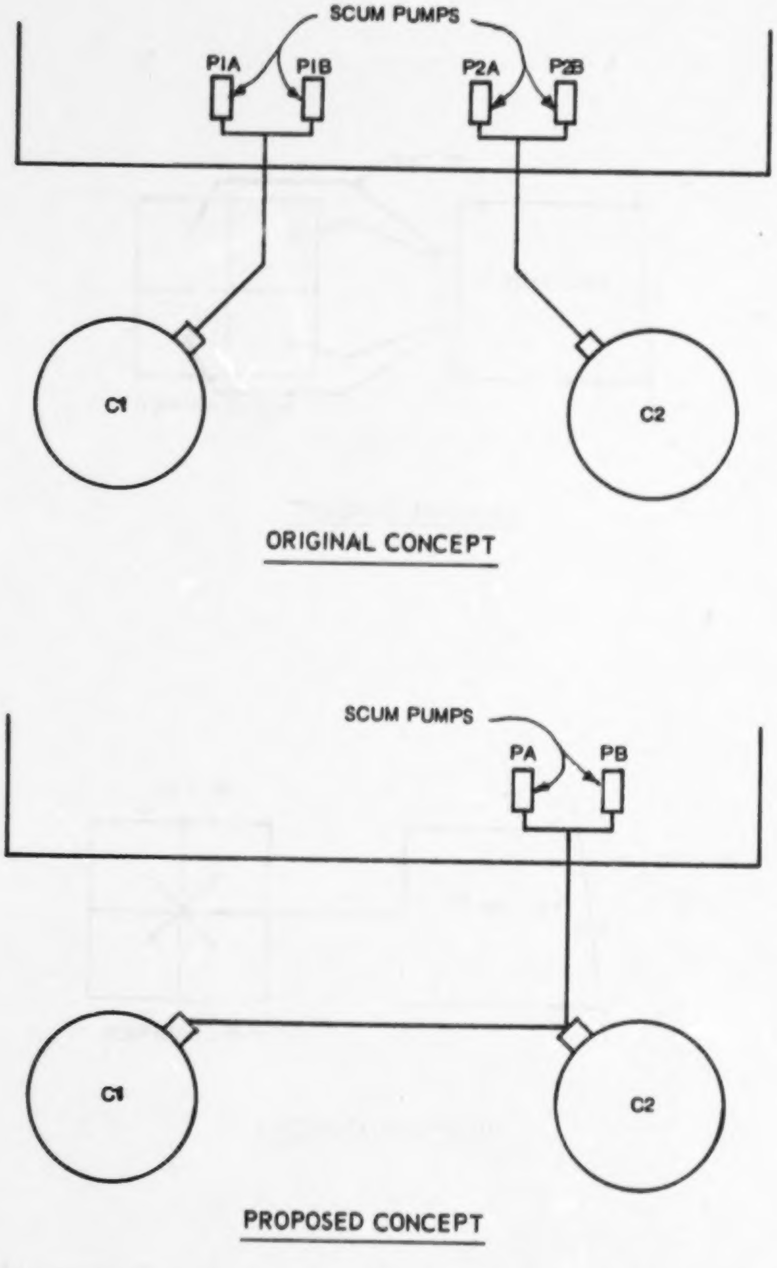

SCUM PUMPS
P1A
P1B
P2A
P2B
C1
C2
ORIGINAL CONCEPT
SCUM PUMPS
PA
PB
C1
C2
PROPOSED CONCEPT

Figure 37. Simplify scum handling system.

EQUIPMENT & PROCESS LAYOUT

Rearrange Sludge Building

In the original concept major modifications to the incinerator were included for providing the option of operating in a pyrolysis mode. Dewatering equipment would be converted to a filter press so that the combined primary/ secondary sludge will be of sufficient dryness for autogenous combustion. A waste heat recovery boiler was also in the design to supplement the existing heating system.

In the proposed concept the pyrolysis option was deleted. It appeared unjustified since the new dewatering equipment would allow the incinerator to operate autogenously.

Use Tertiary Filter Backwash Water for Incinerator Scrubber Water

In the original concept, two recycle flows were returned to head of the aeration basin. The first of these was scrubber water from the incinerators, which used plant effluent for the original supply. The second of these flows was tertiary filter backwash water.

The proposed concept recommended using tertiary filter backwash water as the supply for the incinerator scrubber. This concept eliminated one half of the return flow. A sketch of both the original and proposed concepts is shown in Figure 38.

Combine Grit Removal and Preaeration in a Single Structure

Grit removal and preaeration were originally designed as separate operations in separate structures.

The proposed change used an aerated grit chamber to combine grit removal and preaeration into the same operation and structure.

Reduce Number of Clarifiers From 5 to 4

The plant under consideration was 50 mgd, and in the future was to undergo a 25 mgd expansion. For the initial 50 mgd phase, 5 secondary clarifiers were used.

Using 4 instead of 5 secondary clarifiers in the 50 mgd phase was proposed to simplify the addition of the future 25 mgd phase (2 clarifiers) and result in 6 clarifiers of equivalent size at ultimate capacity.

Make Site More Compact

To construct the treatment facility at the site selected, about 65% of the site would have required dewatering during construction. Additionally, a rather extensive ditch system would have been required for groundwater elevation control and for stormwater. The original design was costly in

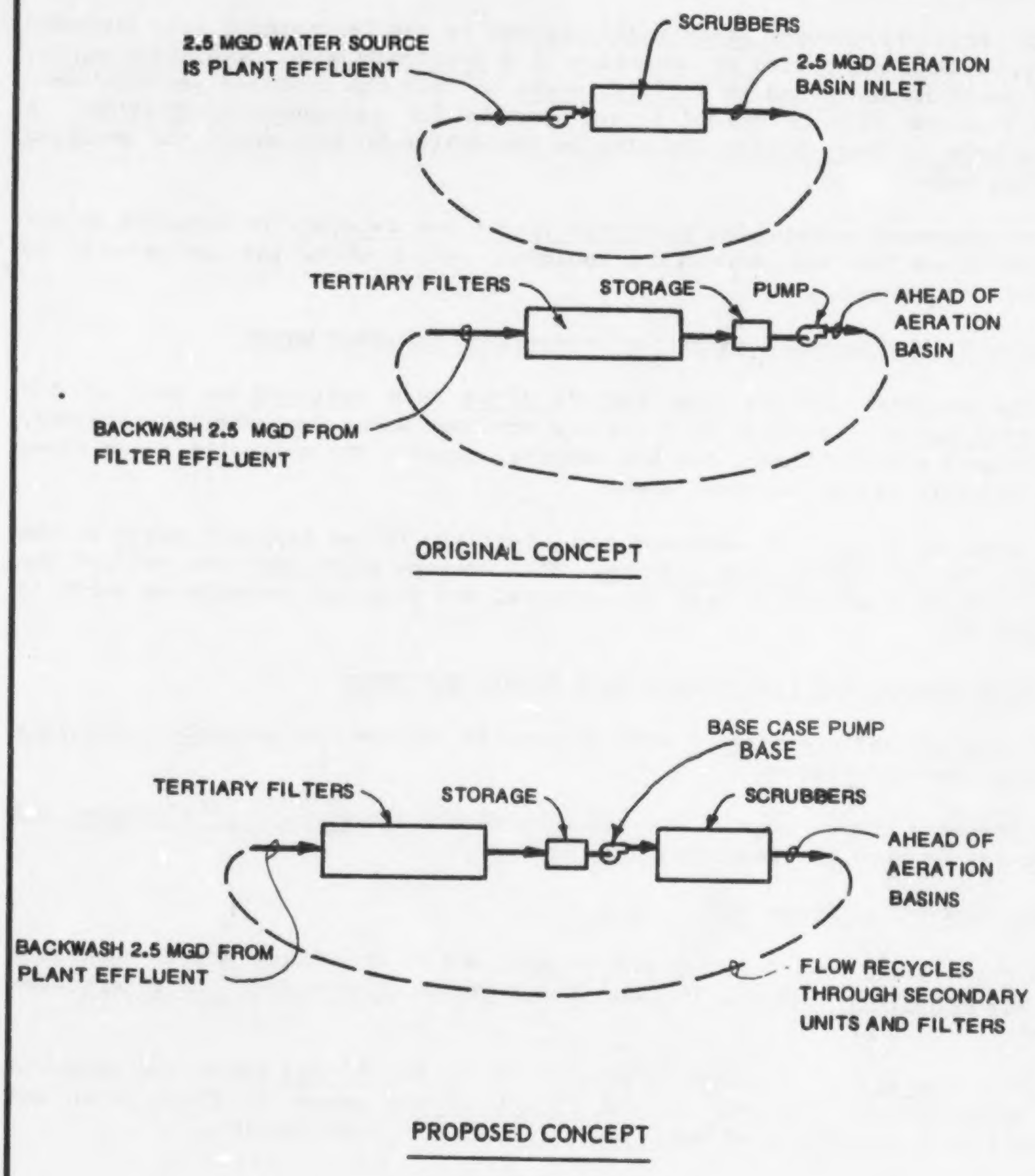

SCRUBBERS
2.5 MGD WATER SOURCE IS PLANT EFFLUENT
2.5 MGD AERATION BASIN INLET
TERTIARY FILTERS
STORAGE
PUMP
AHEAD OF AERATION BASIN
BACKWASH 2.5 MGD FROM FILTER EFFLUENT
ORIGINAL CONCEPT
BASE CASE PUMP
BASE
TERTIARY FILTERS
STORAGE
SCRUBBERS
AHEAD OF AERATION BASINS
BACKWASH 2.5 MGD FROM PLANT EFFLUENT
FLOW RECYCLES THROUGH SECONDARY UNITS AND FILTERS
PROPOSED CONCEPT

Figure 38. Scrubber water recycle streams.

construction, and the treatment facilities were spread out on the site substantially.

Compacting the plant onto the site was proposed as a means of reducing the intitial capital cost, site dewatering, road length and the cost of electrical distribution. A secondary benefit was the availability of more land for future expansion when required.

Relocate Clarifiers Closer to Aeration Basins

A plant service road and a flood control channel were placed between the primary clarifiers and the aeration basins.

Relocation of the flood control channel and the plant service road were proposed. This allowed the primary clarifiers and the aeration basins to be located about 30 feet closer together.

Eliminate New Piping Between Secondary Clarifiers and Chlorine Contact Tank

At an existing plant which was being expanded, a box conduit was used to convey secondary effluent to the chlorine contact chamber. Although the conduit could handle the original plant design flow of 27 mgd, it could not carry the new ultimate design flow of 36 mgd. The design for the plant expansion abandoned the existing box conduit and used a new 66-inch diameter reinforced concrete pipe.

The proposed concept recommended continued use of the existing box structure until its capacity was reached, and then adding a parallel pipeline at a later date when future flows were more definitively known.

Modular Design of Equipment

The original design utilized a complex of circular primary clarifiers, rotating biological contactors, and a complex of circular secondary clarifiers. Primary and secondary sludge pumping stations were in separate locations, as was the effluent pumping station, process return pumps, and the control building.

The equipment was rearranged into a modular concept utilizing rectangular primary and secondary clarifiers, and channels for conveyance of flows between unit processes. A common pipe gallery was proposed, and all pumping facilities were housed in the control building. Figure 39 shows schematics of the original and proposed systems.

Rearrange Plant Layout

The original concept utilized a spread out concept with little common wall construction. There was a high degree of "back and forth" conveyance of flows on-site.

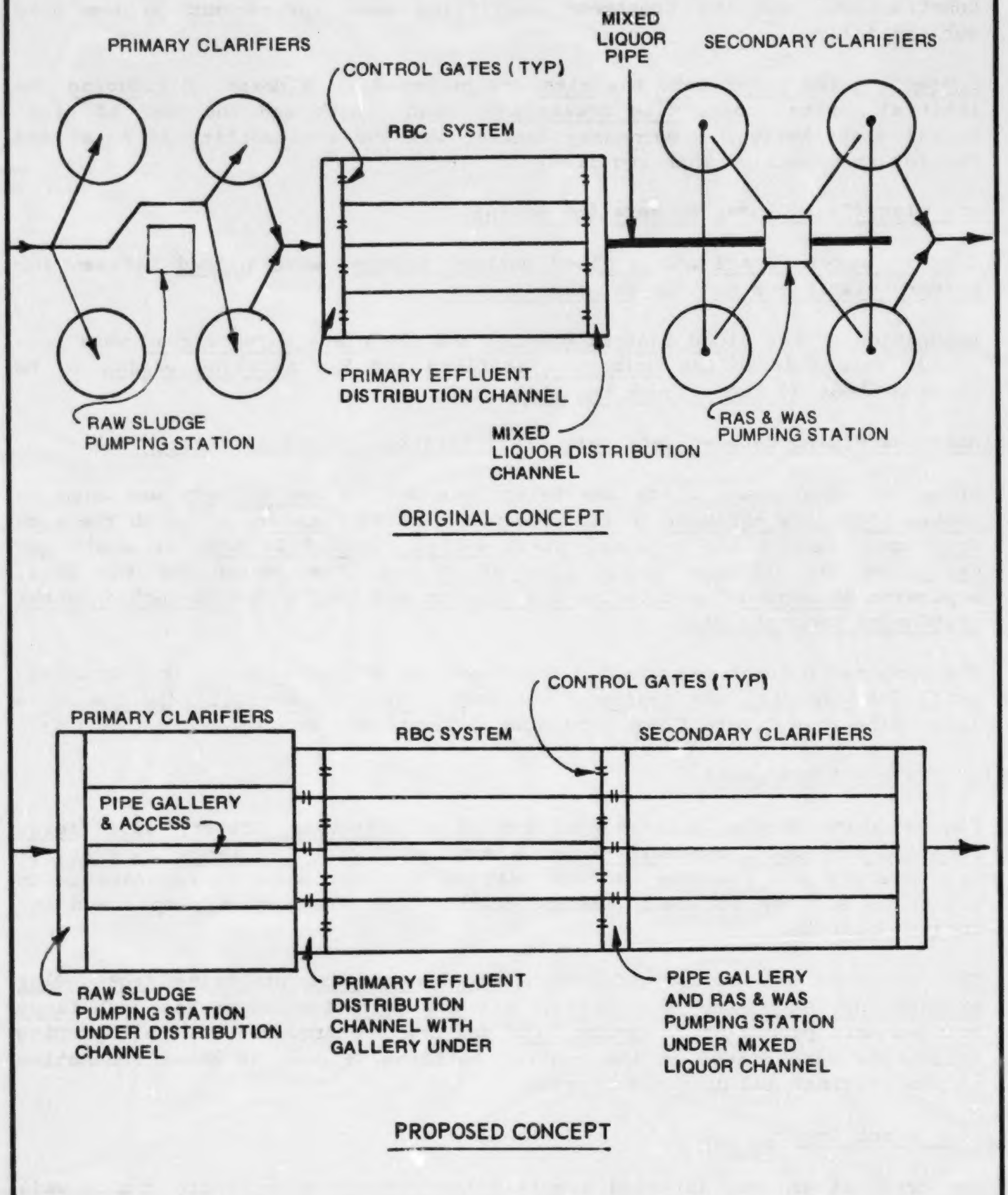

PRIMARY CLARIFIERS
CONTROL GATES (TYP)
MIXED LIQUOR PIPE
SECONDARY CLARIFIERS
RBC SYSTEM
PRIMARY EFFLUENT DISTRIBUTION CHANNEL
RAW SLUDGE PUMPING STATION
MIXED LIQUOR DISTRIBUTION CHANNEL
RAS & WAS PUMPING STATION
ORIGINAL CONCEPT
CONTROL GATES (TYP)
PRIMARY CLARIFIERS
RBC SYSTEM
SECONDARY CLARIFIERS
PIPE GALLERY & ACCESS
RAW SLUDGE PUMPING STATION UNDER DISTRIBUTION CHANNEL
PRIMARY EFFLUENT DISTRIBUTION CHANNEL WITH GALLERY UNDER
PIPE GALLERY AND RAS & WAS PUMPING STATION UNDER MIXED LIQUOR CHANNEL
PROPOSED CONCEPT

Figure 39. Modular design of unit processes.

The proposed concept was a more compact arrangement, using about 25% less land area. Piping requirements were substantially reduced and a high degree of common wall construction was utilized.

Flow Equalization After Primaries

The original concept was to construct flow equalization basins ahead of preliminary treatment, which would require mixing and aeration to maintain suspension of heavy materials.

The alternative is to place the flow equalization after preliminary and primary treatment. The effect of this change would reduce the number of pump stations required from two to one. It would also make the water storage easier by removing the majority of the grit, screenings and the primary sludge. The removal of the heavy loadings prior to equalization also reduced the requirements for aeration in the equalization basin.

Relocate Air Blower Building to Slab on Grade

In the original concept, an air blower building with four air blowers was located on the ground floor of an intermediate pump station building. The blowers were positioned over the below-grade dry well for a pump station and because of their location, the blowers require special structural design to support them and dampen the associated vibrations. This location also requires over 200 feet of 42-inch air header pipe to convey the air from the blowers to the aeration tanks.

In the proposed concept the blowers were located in a slab-on-grade building, thereby requiring less structural support and vibration dampening. This proposed building would be located with a common wall to the new aeration tank which also can reduce the cost of the building and the length of the required 42-inch air header.

Relocate Odor Control Scrubber and Blower to Outside of Building

In the original design, the odor control scrubber and blower were located within the screening building.

The proposed concept suggested locating the scrubber and blower outside the screening building on a concrete pad. This allowed the screening building to be reduced in size. A sketch showing the original and proposed concepts is shown in Figure 40.

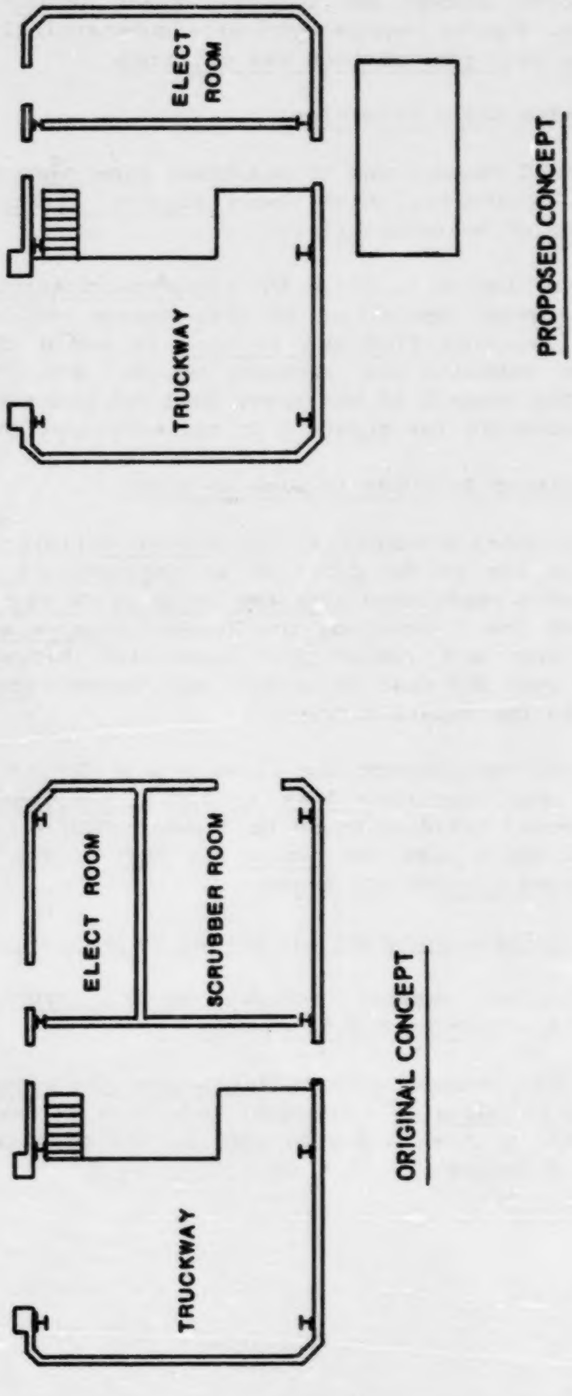

ELECT ROOM
TRUCKWAY
PROPOSED CONCEPT
ELECT ROOM
SCRUBBER ROOM
TRUCKWAY
ORIGINAL CONCEPT

Figure 40. Relocate odor scrubber outside building.

HYDRAULICS AND HYDRAULIC GRADELINE

Lower Plant to Lessen Influent Pumping

A new treatment facility was layed out with an influent pumping station, and then gravity flow through the plant into an adjacent river. The plant facilities were located at a high enough elevation to allow gravity flow even during 100 year flood flow in the river. Accommodation of this gravity flow condition during the 100 year flood flow resulted in pumping requirements which were substantially in excess of normal requirements.

The proposed concept recommended lowering the plant hydraulic gradeline to an elevation which would allow submergence of the weirs of the final clarifier (but not the final clarifier itself) during a 100 year flood. The proposal resulted in a significant life cycle energy savings. Additional savings might also result by lowering the plant even further and adding a standby effluent pumping station for flood situations approaching the 100 year flood.

Reduce Filter Structure Height

The original concept proposed using a 12.75' filter operating depth and 2' of filter freeboard to achieve 24 hour filter runs at peak rates.

The proposed concept recommended reducing the filter operating depth to 10' and the filter freeboard to 1.5'.

Use Flow Splitter Boxes

The original concept provided a flow control structure with flow meters and automatic butterfly valves to split the primary effluent and return sludge between the aeration tank pairs. This arrangement was also used to limit the flow to the secondary process, with excess primary influent to be bypassed to the chlorination facilities.

In the proposed concept two weir boxes were provided to split flows, one weir box for primary effluent and one for return sludge. The weir boxes would have the capability of splitting the flow either 1/2:1/2 or 1/3:2/3 between the aeration tanks. Also, steel bypass launders and weirs would be provided in the primary tank effluent channel to collect overflow to the chlorination.

Lessen Head on Effluent Pumping Station

The original design for a plant included future effluent filtration facilities in the hydraulic profile of the plant. With inclusion of these facilities, a relatively deep effluent pumping station was required. Without, inclusion of these future facilities, only a relatively shallow pumping station was required, and pumping would only be required during flood conditions in the adjacent river.

Since the future requirement for effluent filtration was uncertain, it was proposed to raise the effluent pumping station to the highest elevation possible for the first stage plant construction. Such an elevation increase then allowed gravity flow during all times except flood conditions in the adjacent river, when effluent pumping was required. Overall, eight feet of elevation was saved.

Grit Removal After Raw Sewage Pumping

The original design located the grit removal, comminution and raw sewage pumping in a deep gravity fed structure.

The proposal was to place the grit removal and comminution downstream from the raw sewage pumps, and raising the grit removal and comminution facilities to at-grade.

Raise Elevation of the Influent Screw Pumps

In the original concept, the hydraulic grade line in the pump station influent pump trough was 5 feet above the top of the screw pump.

The proposed concept recommended raising the bottom elevation of the influent pump trough by approximately 4' thereby placing the hydraulic grade line only 1' above the top of the screw. The proposal would shorten the screw by 8' and reduce the horsepower required from 75 to 60. A sketch of the original and proposed concepts is presented in Figure 41.

Lower Primary Treatment Processes and Eliminate Influent Pumping Station

The original concept provided hydraulic profile with pumping required prior to the new primary settling tanks. The primary tanks were located on a high hillside to allow for gravity flow through roughing towers with a 24' media depth, and then to intermediate clarifiers. Effluent from the intermediate clarifiers was then to be pumped to aeration tanks. During low flows, some of the intermediate flow was also to be recycled to the roughing towers.

The proposed concept lowered the new primary clarifiers to allow gravity inflow, thus eliminating the primary pump station. The roughing towers were reduced in height by using only 20' of media depth and lowering the base of the towers to allow for gravity flow into the towers from the primary clarifiers. This new hydraulic profile only required pumping of roughing tower effluent to the intermediate clarifiers, thereby eliminating one of the pumping stations.

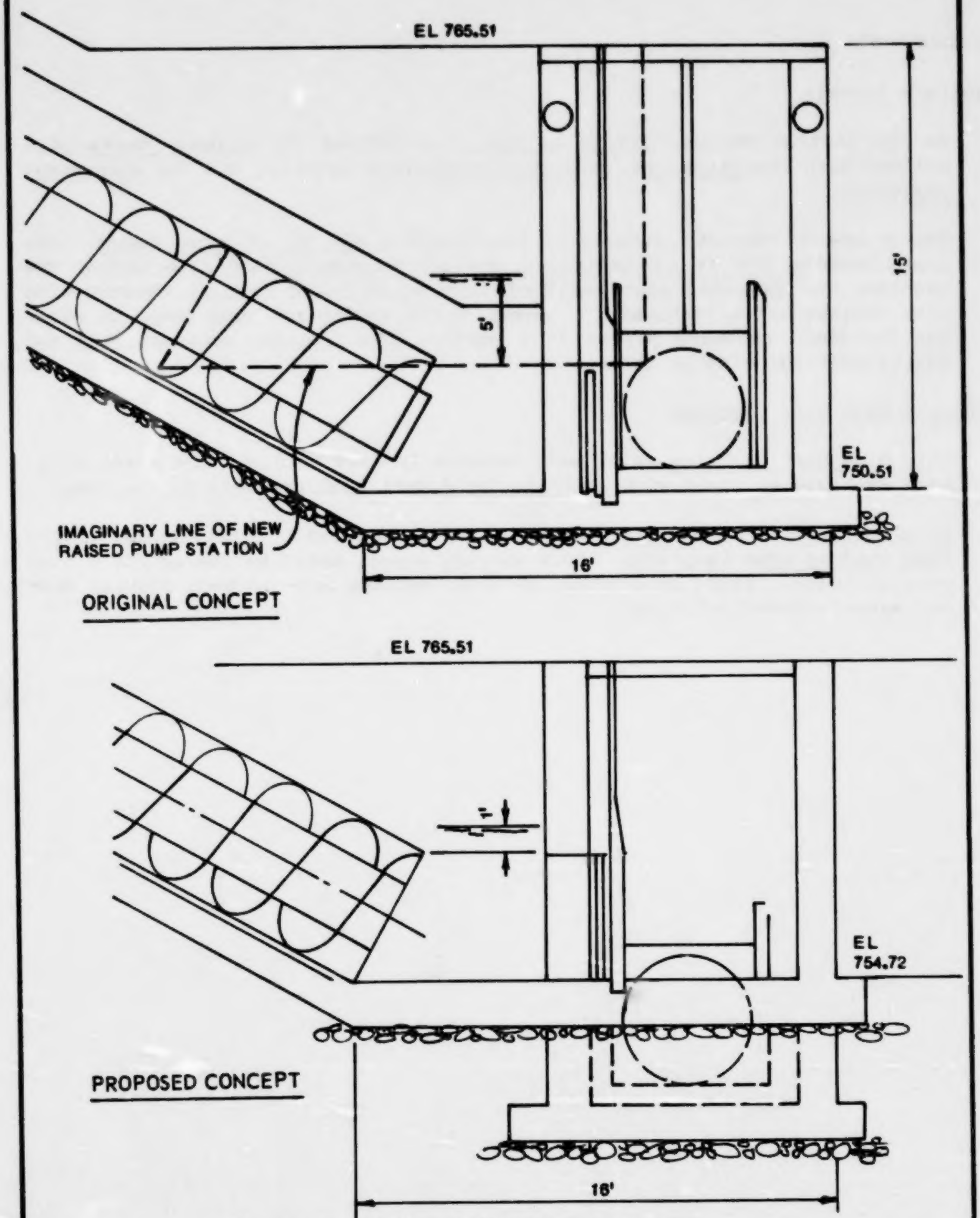

EL 765.51
15'
5'
EL 750.51
IMAGINARY LINE OF NEW RAISED PUMP STATION
16'
ORIGINAL CONCEPT
EL 765.51
1'
EL 754.72
PROPOSED CONCEPT
16'

Figure 41. Raise influent screw pumps.

MISCELLANEOUS

Eliminate Tunnels

In the initial design, 550 ft of tunnel connected the primary tanks pipe gallery with the digesters, secondary tanks pipe gallery, and the operations building.

The proposed concept recommended constructing 425 ft of pipe trench with approximately 350 ft of protected surface walkway, thus eliminating the tunnels. The proposed plan resulted in a significant initial construction cost savings and eliminated the tunnel drain system and sump pump. By placing the small pressure piping in a surface pipe trench, accessibility for maintenance was greatly increased.

Eliminate High Mast Lighting

Five High Mast Lighting units were originally used to light the plant site. Each mast was equipped with multiple 1,000 watt high pressure sodium lamps.

Elimination of the High Mast units was proposed, with substitution of 25' high roadway type luminares. 400 W mercury vapor, metal halide or 250 W high pressure sodium lamps were proposed. Cost savings were in both initial cost and annual electrical costs.

CHAPTER 5

BUILDINGS OR STRUCTURES

SIZE

Reduce Size of Garage

The original concept provided an enclosed garage with parking bays 20 feet wide and with 20 foot high clearance.

The proposed concept recommended reducing the bay width from 20 feet to 16 feet wide and the ceiling would be lowered from 16 feet to 10 feet, thus reducing the volume of the entire building.

Reduce Garage Floor Slab Thickness

In the original concept a garage was provided with a slab on grade. The slab was 8-inches thick.

In the proposed concept the slab would be reduced to 6-inches thick, which was capable of supporting the design load of 400 to 500 psf.

Reduce Ceiling Heights in Administration Building

In the original concept a two story administration building was provided. The distance from the ground floor to the second floor was 12 ft, 6-inches and from the second floor to the roof was 11 ft, 6-inches.

In the proposed concept the overall height of the building was reduced by two feet, one foot on each floor. This reduction was accomplishable because the ceiling heights in the original design were greater than required for an administrative building.

Reduce Size of Operations Building Basement

In the original concept, the operations building had a partial basement which was used for a blower room, mechanical room, electrical room and storage area. The first floor area included two offices, a conference room, and 3600 sq ft of workshop and truck space.

In the proposed concept, blower room and storage area in the basement were reduced in size, and the first floor workshop and truck space were reduced to 2900 sq ft.

Reduce Building Size by Moving Bulk Storage Tanks Outside

In the original concept fiberglass storage tanks were used for bulk storage of liquid polymer, ferric chloride, and lime. All of the bulk storage tanks were located indoors.

In the proposed concept, the chemical storage units were located outside of the building, in an area accessible to trucks to facilitate truck delivery.

LOCATION

Eliminate Conveyors by Relocating Vacuum Filter Building

In the original concept, both existing and new vacuum filters were used for sludge thickening. Due to space limitations, the new vacuum filters were located in a new building, which was not immediately adjacent to the existing building. Two conveyors were used to connect the existing and new buildings.

The proposed concept placed the two buildings adjacent to each other, thereby eliminating the conveyor belts and using a common wall. Figure 42 shows sketches of the original and proposed concepts.

Raise Tunnel Elevation

The original concept used tunnels which were several feet below grade.

The proposal recommended raising the tunnels, making the top of the tunnel at ground elevation. The tunnel top would serve as the sidewalks in this proposal.

Relocate Blower Building from Top of Aeration Basins to Ground Surface

The original concept located the blower building above the aeration tanks supported by a concrete beam and column framing system.

The proposal recommended relocating the blower building to a location adjacent to the aeration basins. The new location would place the building on a concrete slab directly on the soil, thereby providing better support than the original concept.

Place Boilers Inside Existing Digester Control Building

The initial design to upgrade a treatment facility included construction of a new boiler room beside existing digesters.

The proposed concept suggested placing the new boilers in the present digester control room to eliminate the construction cost of a new building. The proposed design only required modification of the existing building and provided an additional benefit by reducing the amount of piping required.

Relocate Blowers to Aeration Tanks

In the original design concept the blowers were housed in a portion of the power and generation building. A long run of 42-inch air pipe was required between the blowers and the aeration building.

The proposed concept recommended relocating the blowers to a separate blower building and reducing the size of the original power/generation building. The new blower building would be located adjacent to the aeration tanks and thus would eliminate a substantial portion of the 42-inch air piping.

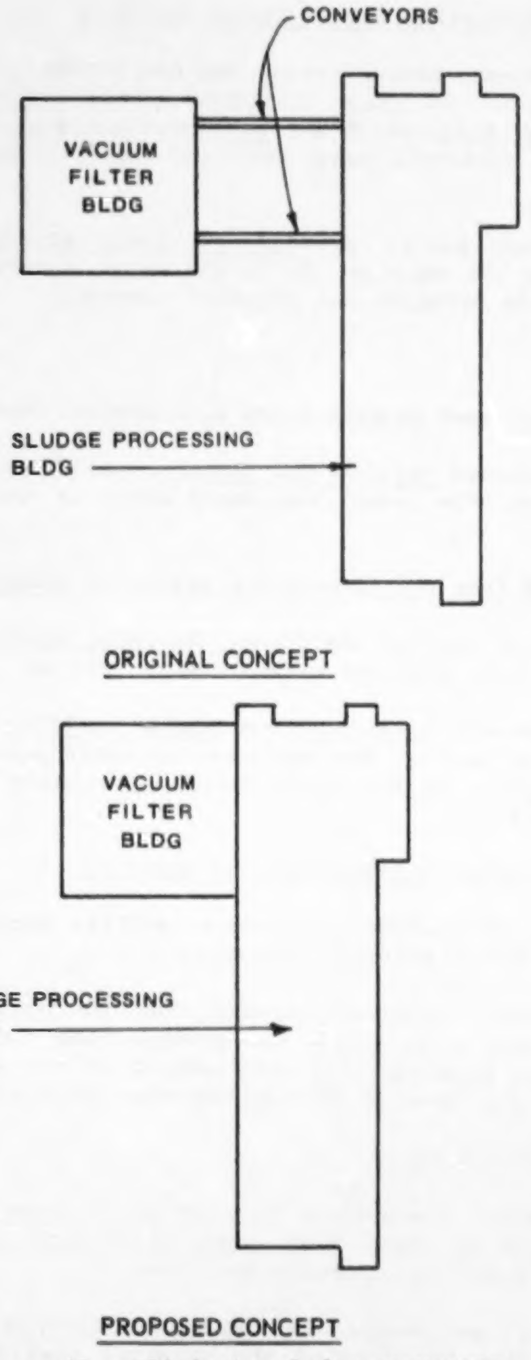

CONVEYORS
VACUUM FILTER BLDG
SLUDGE PROCESSING BLDG
ORIGINAL CONCEPT
VACUUM FILTER BLDG
SLUDGE PROCESSING BLDG
PROPOSED CONCEPT

Figure 42. Eliminate sludge conveyors.

Relocate the Blower Building and Make a Common Wall with the Aeration Basin

In the original concept the blower building was located above the aeration tanks supported by beam and column framing system. A superstructure with the same type of architecture as an adjacent building enclosed the blowers.

The proposed concept would relocate the blower building between two aeration tanks, along with the secondary sludge pump station, thereby using the tank walls as common walls and masonry walls for a portion of the building extending above the tanks. The proposed concept also used precast double tees for the roof system.

Omit Gravity Thickened Sludge Holding Tank and Long Suction Lines/Add Pumps

The original concept withdrew 6-8% sludge by gravity from sludge thickeners, and then stored the sludge in a sludge holding tank. A thickened sludge pumping station was located adjacent to the sludge holding tank.

Due to the length of the sludge lines between the thickeners and the holding tanks it appeared and that clogging would occur periodically. The proposed concept eliminated the holding tank and placed a thickened sludge pumping station between every two thickeners, thus eliminating the long suction lines. Sketches of the original and proposed concepts are shown in Figure 43.

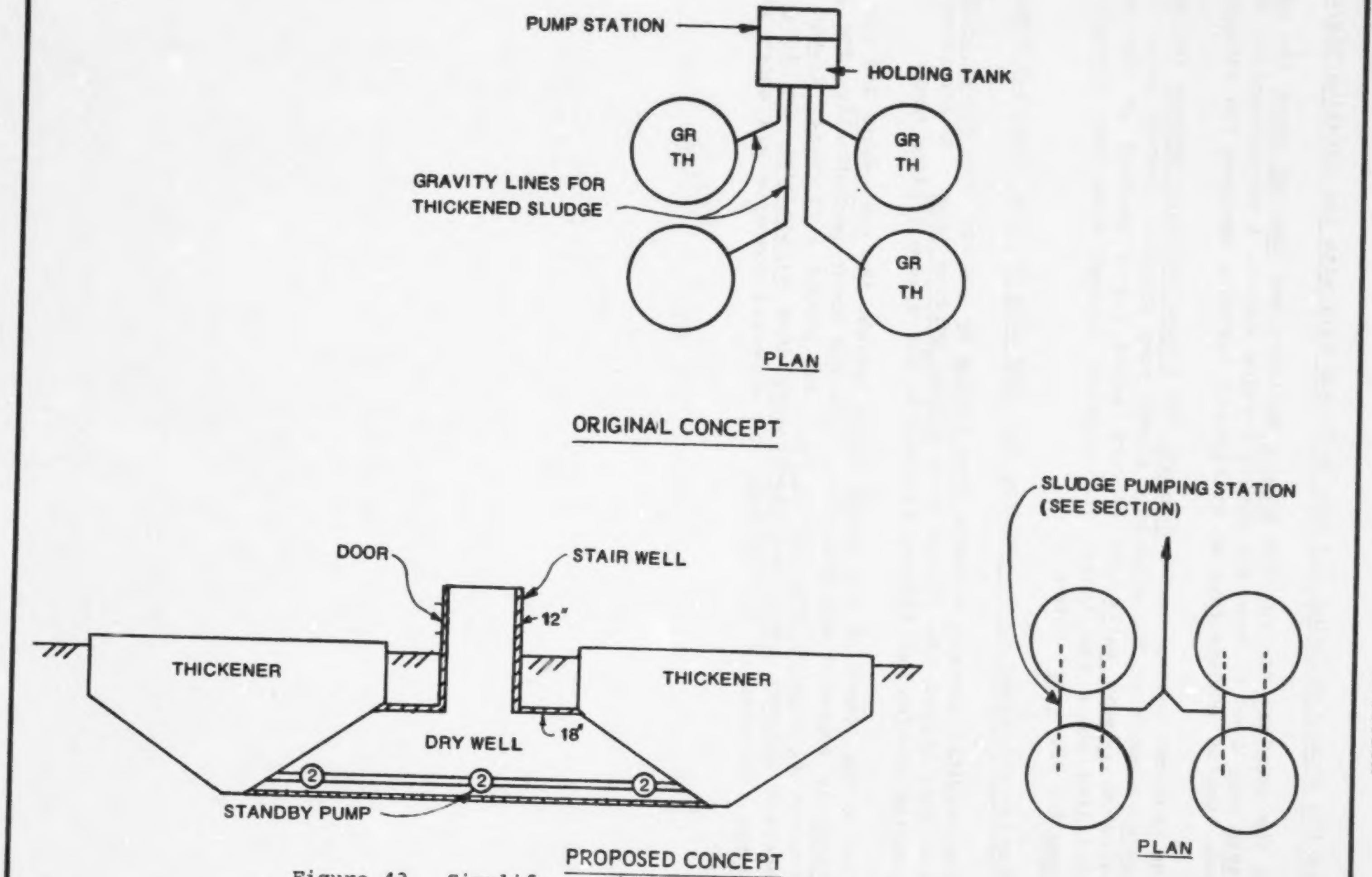

PUMP STATION
HOLDING TANK
GR
TH
GR
TH
GRAVITY LINES FOR
THICKENED SLUDGE
GR
TH
PLAN
ORIGINAL CONCEPT
SLUDGE PUMPING STATION
(SEE SECTION)
PLAN
DOOR
STAIR WELL
12"
THICKENER
THICKENER
DRY WELL
18"
2
2
2
STANDBY PUMP
PROPOSED CONCEPT

Figure 43. Simplify gravity sludge thickening system.

MATERIALS

Replace Cast-in-Place Roof with Precast Concrete Slabs

The original design concept included the use of cast-in-place reinforced concrete roof for a building which housed several facilities, including an open gravity thickener tank.

The proposal recommended using a metal roof deck instead of the cast-in-place concrete roof.

Use Precast Floor Slabs Instead of Cast-in-Place Concrete Floors

The original design called for the use of cast-in-place reinforced concrete floor slabs for the secondary treatment building.

The proposed concept recommended using spandeck floor slabs for the building.

Change Cover Material on Tanks

The original concept included covered rectangular tanks for primary clarification and aeration. The original covers were to be constructed from fiberglass material.

The proposed concept used precast, pre-stressed hollow-core concrete slabs.

Eliminate Basement Waterproofing

The original concept used waterproofing for the pump station basement in the solids handling building, as well as a pumped underdrained system.

The proposed concept eliminates the basement waterproofing because it was considered to be redundant with the pumped underdrained system.

Use Pre-Engineered Lightweight Metal Building

A concrete block building was used in the original design for shop facilities and engine-generator combinations.

Use of a pre-engineered lightweight metal building was proposed as a replacement for the concrete block building.

Use Steel Frame Stairs Instead of Cast-in-Place Concrete

Originally, the digester building stairs were designed for cast-in-place concrete.

It was recommended that steel frame and precast concrete stairs be used in the digester building and pump drain pit.

FLOOR PLANS

Use One Single Building to House All Plant Equipment

The original plan had separate buildings to house chlorine feed equipment, sludge handling equipment, plant heating equipment, aeration equipment, and the administration and laboratory facilities.

It was decided that the construction of a single multipurpose building to house the process equipment was not only cost effective, but also would improve the functionality of the facility. Laboratory and office space also could be incorporated into the building, if desirable.

Layout Change for Sludge Dewatering Building

A sludge dewatering building was designed with dewatering equipment on the upper floor, and a truck loading area below. The loading area was completely enclosed, and required a truck to back into the building for loading.

An open drive-through truck loading facility was proposed. The drive-through capability would eliminate the need for sludge trucks to back into the loading area, resulting in overall ease of operating the sludge hauling plan.

Reduce Chlorine Building Size

Original design placed for the chlorine feed and storage in the same building. Heating of the chlorine building was required about 200 days per year.

The proposed concept recommended using outdoor storage for most of the on-site chlorine storage, reducing the building size by approximately 50%. Savings from this revision were in the building and the monorail crane.

Eliminate Covered Vehicle Storage Area

For a plant located in a southern climate, the original design provided a covered vehicle storage area.

Elimination of the covered the vehicle storage area was proposed.

Redesign Control Building to One Level

A two-story control building was the initial concept, with about 5,000 square feet on the second story. The second story contained a large display area, a conference room, a restroom and several hallways, as well as other areas.

The proposal recommended eliminating the second story, and increase the first floor area by 2700 square feet. The proposal resulted in an overall reduction of about 2300 square feet.

Reorganize Floor Plan and Placement of Equipment

In the original concept the solids treatment building was arranged into three levels. In the basement were the lower access to the incinerators, heat treatment reactors and storage space. On the first floor were offices, electrical switch gear, laboratory, restroom facilities, lunch and conference room, vacuum filters, vacuum pumps and accessory equipment, heat exchangers and upper access to the incinerators and heat treatment reactors. Conveyor belts from each vacuum filter approach a main conveyor belt running across the first floor at a 90° angle to the main conveyor belt. The control room with motor control centers and instrument panels was located on a mezzanine level above the first floor.

In the proposed concept, all first floor facilities were compressed into a smaller area, and multipurpose rooms were established. The vacuum filters were rotated 90 degrees to discharge directly onto the main conveyor directly and accessory equipment was relocated closer to the vacuum filters. The motor control centers were relocated to the electrical switch gear room on the first floor, reducing the space required in the mezzanine control room.

Eliminate Housing for HVAC Equipment

A major interceptor pumping station had a superstructure which was 56 ft above ground level. The top two floors of the superstructure housed heating, ventilating, and air conditioning equipment.

The proposed concept recommended eliminating the top two floors, reducing the overall height of the superstructure from 56 ft to 30 ft. In the proposal, the HVAC equipment would be mounted on the roof of the pumping station.

Reduce Volume of Building or Eliminate Building

In the original design, many areas of the treatment plant were covered, such as the headworks, the grit channels, dissolved air flotation units, and the post-chlorination/dechlorination areas. All of these areas required ventilation and for most, odor scrubbing was also required. In the headworks area, a rather substantial loft was utilized to house a traveling bridge crane.

A review of the housing needs for the various facilities revealed that reduction or elimination of the building requirements for the grit channels, dissolved air flotation and units and post-chlorination/dechlorination basins was justified. Housing of the headworks was still recommended, but elimination of the loft and the traveling bridge crane was proposed since portable cranes could be used for the periodic removal of equipment in the headworks area.

Eliminate Housing of Exhaust Heat Recovery Muffler System

A two-story building was planned to house an engine/generator combination and an exhaust heat recovery muffler system. The engine/generator was to be on the ground floor, and the exhaust heat recovery muffler system on the second floor.

Elimination of the second floor was recommended as there was no need to house the exhaust heat recovery muffler system.

Modify Control Building to Reduce Footage

Originally the control building was designed as a two-story structure with a total gross area of 5,000 sq ft. The ground floor covered 2,900 sq ft and the second floor covered 2,100 sq ft.

The proposed concept suggested modifying the control building into a one-story building and eliminating some of the duplicate spaces. By combining the entrance and reception area, eliminating duplicate restrooms and combining the lab office with the laboratory, and reducing the building to a single story, the space requirements were reduced to 3,600 sq ft.

Reorganize Maintenance Building

The maintenance building as originally designed was 3,600 sq ft. The building included enclosed garages for parked vehicles and equipment.

The proposed concept recommended reducing the amount of heated space in the maintenance building. By reducing the total square footage to 3,000 sq ft. The vehicles would be in a covered area with open sides.

Eliminate Administration Building Basement, Move Proposed Improvement to First Story Level

The original design constructed an administration building with a basement of 3,700 sq ft consisting of a boiler room and shop serviced by an elevator and two stairs.

The proposed concept recommended eliminating the basement, relocating the boiler room to the first floor level and relocating the shop to a garage structure.

TYPE OF CONSTRUCTION

Use Gratings Over Effluent Troughs

The original concept used a reinforced concrete slab for the cover to the raw wastewater screw pump.

The proposed concept simplified construction by substituting grating and handrails over the screw pump.

Eliminate Walkway Enclosure

In the original concept a 35 foot long walkway connected two buildings. The walkway was enclosed with masonry walls and a concrete roof.

In the proposed concept, the masonry walls and the concrete roof over the walkway were eliminated.

Redesign Walls of Sludge Facility Building

The original design consisted of six anaerobic digesters connected through a center core support building. The center core building was a multilevel concrete frame building with a steel frame roof system covered with 2-3/4" lift weight concrete plank which was then covered with insulation fill concrete. Walls of the building were masonry.

The proposed recommended concept reducing the weight of the roof section by using metal decks, rigid insulation, achieving roof pitch by tapering the insulation or sloping the structural steel and using cantilevered beams where possible. For the exterior wall, the proposed concept recommended use of utility brick (JUMBO) and reducing the thickness of backup blocks. It was further recommended that the parapet and limestone coping at the top of the building be eliminated in favor of a gravel stop.

Eliminate Superstructure of Return Sludge Pump Station

A return sludge pumping installation utilized a wet well-dry well concept. Pumps were located in the dry well, but were driven by motors which were located in a building above the dry well.

The proposal was for elimination of the building enclosing the motors. An equipment hatch was used for access through the slab and into the dry well.

Delete Tile Floors and Tile Walls of Main Pumping Station

The original concept included quarry tile floors and ceramic tile walls in the influent pumping station.

Use of quarry tile and ceramic tile was proposed to be deleted, with the concrete walls and floors being left in their natural form.

Use Pre-Engineered Building

Originally, dissolved air flotation sludge thickeners were to be housed in a building specifically designed and constructed for that purpose.

The proposal recommended using of a pre-engineered building of approximately the same dimensions.

Use Insulated Steel Building Instead of Concrete Block

The original design called for a blower building with wall construction using a concrete block with a brick veneer.

The proposal recommended a steel-frame, insulated metal panel building.

Use Reinforced Concrete Pipe for Tunnels

The original design used cast-in-place reinforced concrete tunnels.

The proposed design is to construct the tunnels from precast reinforced concrete pipe. Figure 44 shows sketches of original and proposed concepts.

Use Pressure Relief Valves to Prevent Uplift in Chlorine Contact Tanks

The original concept used piles to resist uplift in a chlorine contact chamber.

The proposed concept utilizes pressure relief valves to relieve the uplift pressures in lieu of hold down piles.

Revised Structural Framing

The original concept was a building constructed of structural steel, beam and column with exterior masonry wall of nonload bearing masonry. Columns at the building exterior carry a ten ton crane. The roof consists of a three inch metal decking overlayed by insulation.

The proposed concept would be walls converted to a load bearing wall. The ten ton crane would be carried by reinforced pilasters or solid brick piers. The roof system would be changed to a 16-inch or 32-inch double tee prestressed, precast concrete overlayed by the same insulation and built-up roofing. Flanges of 32-inch tee were increased to four inch thickness to provide more corrosion resistance and higher compressive strength.

Insulated Steel in Place of Precast Panels for Building Walls

The original concept proposed for the administration building, precast concrete panels backed by 2-inch rigid insulation with 6-inch concrete block between the insulation and the concrete panels.

The proposed concept would substitute metal panels for the precast concrete, with no change in the rigid insulation or the block wall. The metal panels

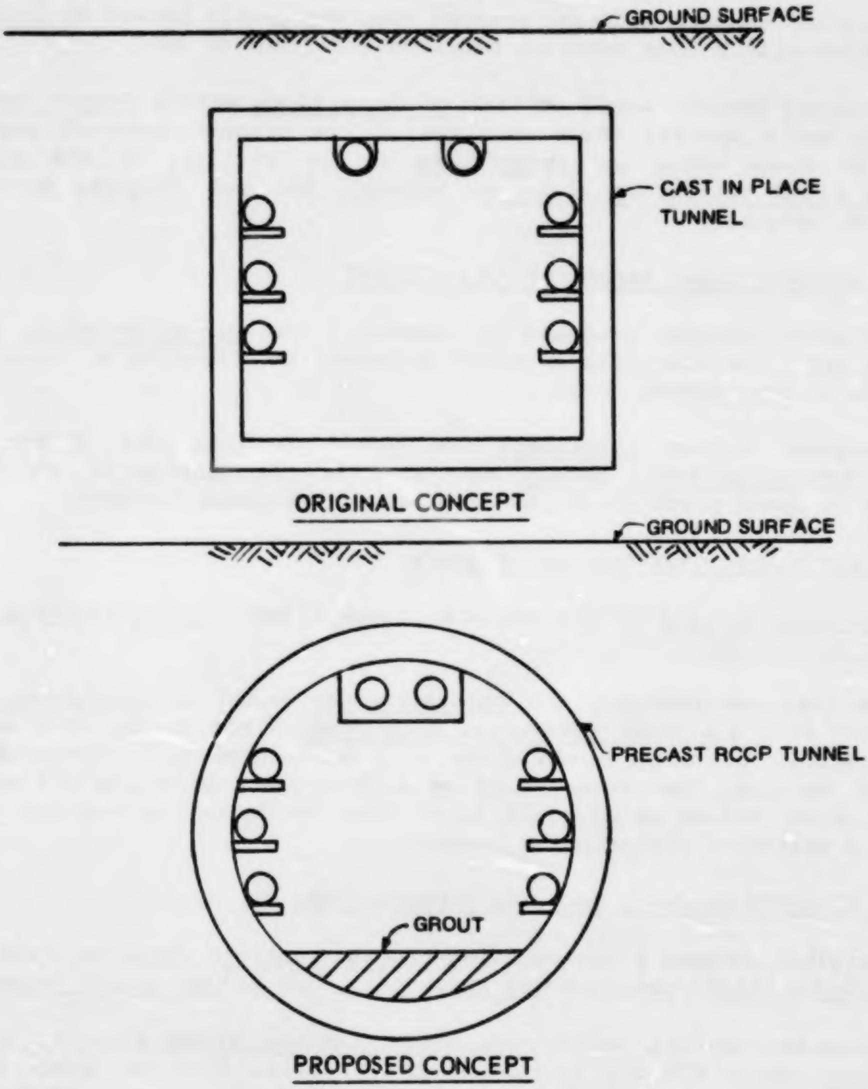

GROUND SURFACE
CAST IN PLACE TUNNEL
ORIGINAL CONCEPT
GROUND SURFACE
PRECAST RCCP TUNNEL
GROUT
PROPOSED CONCEPT

Figure 44. Use reinforced concrete pipe for tunnels.

would be insulated and then attached using girts to fasten to the concrete block wall. Figure 45 shows sketches of the original and proposed concepts.

Substitute Decorative Concrete Block in Place of Precast Concrete Panels

The original concept proposed precast concrete panels backed by 2-inch rigid insulation with 6-inch concrete block on the interior wall.

The proposed concept would utilize concrete block with a 6-inch deep ribbed pattern and a special color in place of the precast concrete panels. The exterior block would use reinforcing in the cavities of the block. The 2-inch rigid insulation would be deleted, but the original 6-inch block would be retained.

Substitute Acoustic Metal Panel for "Sound Blox"

The original concept proposed to construct the blower building utilizing "sound blox" for the walls in order to reduce the transfer of noise from the blowers to the outside area.

The proposed concept eliminated the "sound blox" in area of the building where acoustical metal panels were used on the outside of the building. Figure 46 shows sketches of the original and proposed concepts.

Use Fiberglass Covers Over Tertiary Filters

The tertiary filters in the original concept had a superstructure over the entire filter area.

In the proposed concept, the superstructure would be eliminated and substituted with a movable fiberglass arch cover sized to fit over any one of the filters. The cover would allow work to be done on a filter when it is out of service. The cover would be a fiberglass arch mounted on rollers which would roll on an aluminum track from one filter to another. Figure 47 shows a sketch of the proposed concept.

Substitute Aluminum Geodesic Dome for Concrete Dome

The original concept proposed using precast concrete domes to cover the primary sludge thickeners, gravity thickeners, and sludge decant tanks.

The proposed concept would substitute aluminum frame geodesic domes with aluminum panels for the precast concrete domes. Aluminum domes are lightweight and can be erected as a unit in three to five weeks. Perimeter tension is not transferred to the concrete tank. Openings for skylights, air intakes, or exhaust can be easily inserted as required.

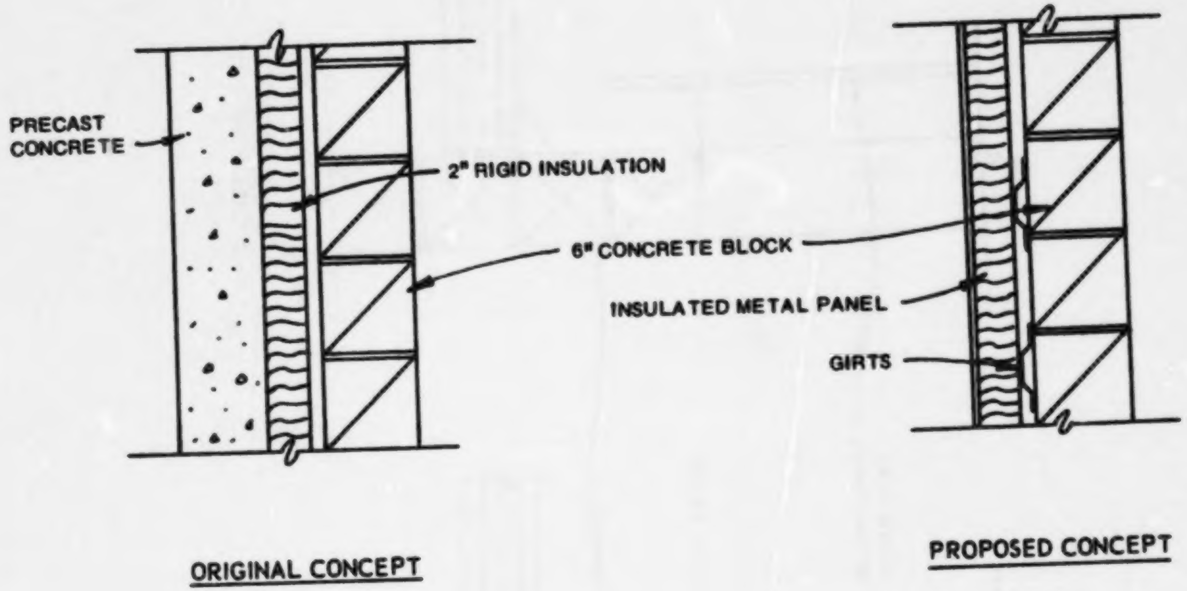

PRECAST CONCRETE
2" RIGID INSULATION
6" CONCRETE BLOCK
INSULATED METAL PANEL
GIRTS
ORIGINAL CONCEPT
PROPOSED CONCEPT

Figure 45. Use insulated steel siding for buildings.

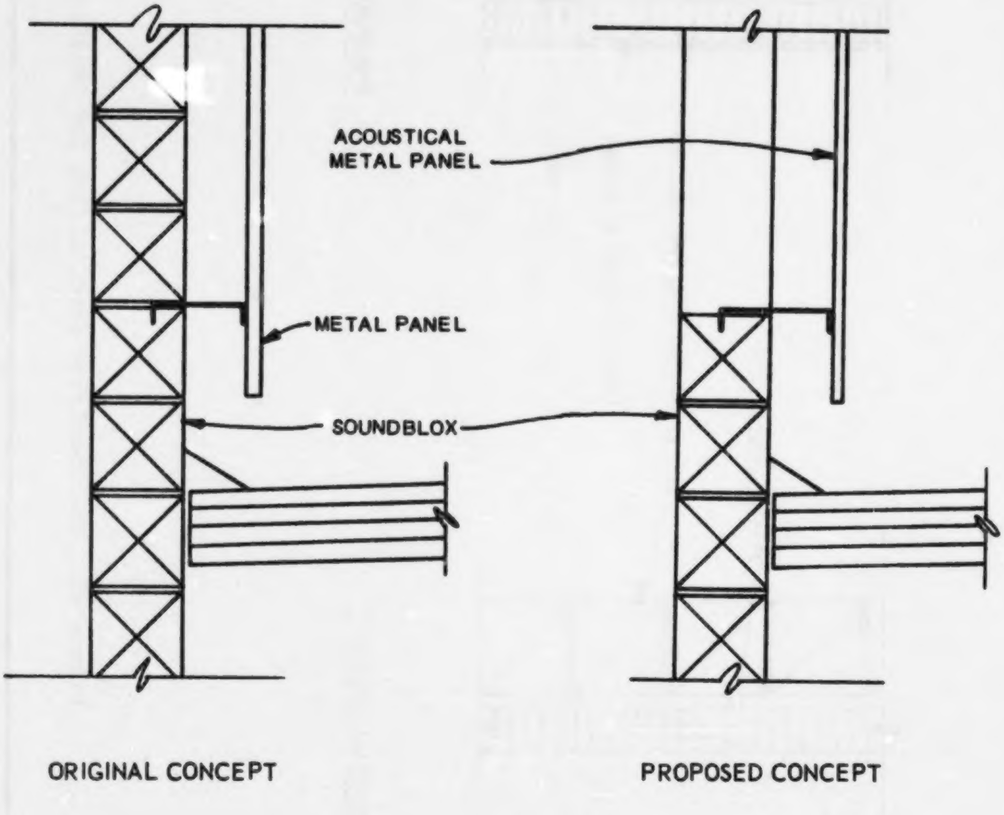
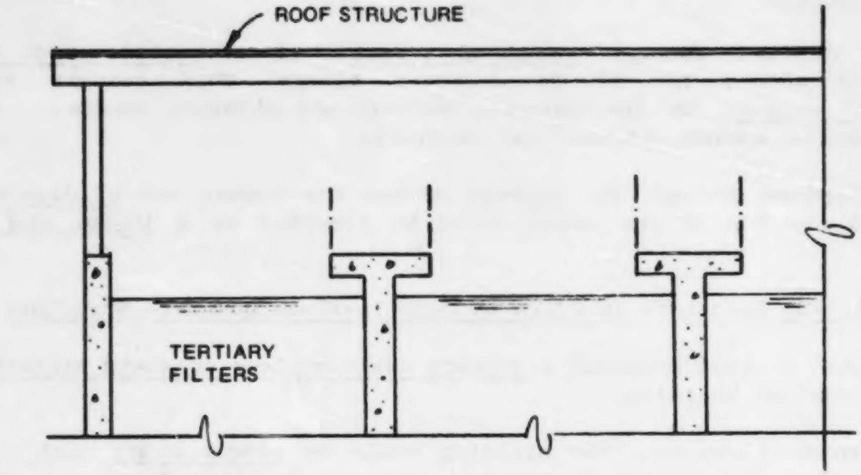
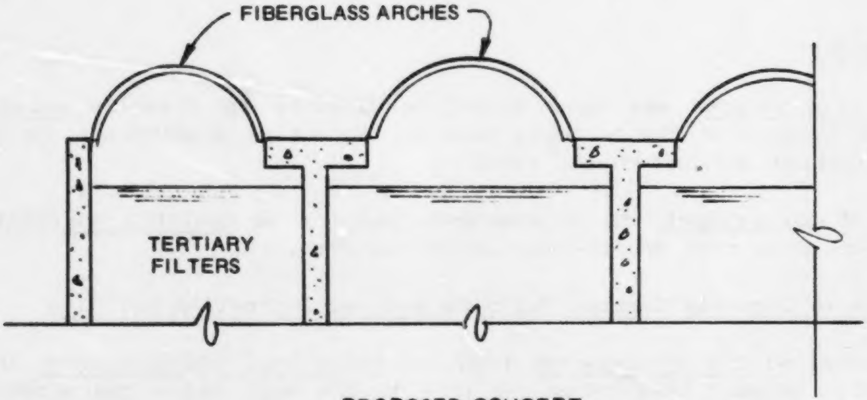

ACOUSTICAL METAL PANEL
METAL PANEL
SOUNDBLOX
ORIGINAL CONCEPT
PROPOSED CONCEPT

Figure 46. Substitute acoustic metal panel for "Sound Blox".


ROOF STRUCTURE
TERTIARY
FILTERS

ORIGINAL CONCEPT


FIBERGLASS ARCHES
TERTIARY
FILTERS

PROPOSED CONCEPT

Figure 47. Use fiberglass covers over tertiary filters.

Use a Ladder and Safety Cage for Access to Roughing Towers in Place of Cantilevered Walkway

In the original concept roughing towers had a cantilevered walkway completely around the 90 ft diameter towers. This concept required structural support for the concrete walkway and aluminum handrail, as well as an aluminum access stairway and handrail.

In the proposed concept the walkway around the towers was eliminated, and access to the top of the tower would be provided by a ladder and safety cable.

Use Precast Tilt-Up Structure in Place of Cast-In-Place Concrete Structure

The original concept proposed a 3-story cast-in-place concrete structure for the main control building.

In the proposed concept, the building would be single story slab on-grade building. The walls would be precast concrete (tilt-up type) and the roof would also be a precast concrete element. Additionally, equipment foundations would be cast independent of the rest of the building.

Change Sidewall Construction on Oxidation Towers

Oxidation towers using plastic matrix media were to be used for carbonaceous BOD removal prior to an aeration basin. Precast concrete walls were to be used for sidewall construction of the towers.

The proposed concept recommended using fiberglass walls instead of the concrete walls.

Eliminate Parapet

A 3 ft high parapet was used around a building to visually shield HVAC equipment located on the building roof and to act as a guardrail for maintenance personnel working on the roof.

Removal of the parapet was recommended, and use of portable guardrails was recommended when roof mounted equipment was serviced.

Reduce Windows in Digester Control Building and Dechlorination Building

The original window arrangement required heavy wall reinforcement in order to transfer seismic loads from the roof to the wall below the windows. The windows in the dechlorination building were located such that little light was admitted and building appearance was only slightly enhanced.

The proposed concept recommended eliminating or reducing the number of windows in the digester control and dechlorination buildings, and using skylights to improve natural light.

Build Sunscreen Over Chlorine Cylinders Instead of Enclosing

In the original design, the chlorine cylinders were to be stored in a completely enclosed structure.

It was recommended that only a sunscreen roof with open sidewalls be used instead of a totally enclosed structure.

APPURTENANCES

Eliminate Elevator

The original concept provided an elevator to operate between the main floor and the pump room floor, a distance of about 17 feet. The elevator would be used only for personnel transport.

The proposed concept was to eliminate the elevator.

Use a Reduced Capacity Crane

The original concept called for a 10 ton capacity motorized crane to move equipment in a pump room.

After checking the weights of the pump room items, it was recommended that the crane capacity be reduced.

Eliminate Traveling Bridge Crane in Blower Building

A building supported traveling bridge crane was used in the blower building, providing the capability of removing any of the motors, blowers, and engines. The crane would have a capacity of 7.5 tons, which would be sufficient to remove an engine completely.

The proposal eliminating the traveling bridge crane, and using a mobile crane with a 5 ton capacity. This concept would require that an engine be disassembled if it had to be removed from the blower building.

Eliminate Covered Parking From the Maintenance Building

The original design used a precast core slab roof over the maintenance building's parking and parts storage areas.

The proposed concept recommended eliminating the roof over the parking area and over the open parts storage area.

CHAPTER 6

ELECTRICAL, HVAC AND CONTROLS

POWER DISTRIBUTION

Substitute PVC Conduit for Rigid Steel Conduit

The original design included rigid galvanized steel conduit encased in a concrete envelope to distribute electricity to the various points of use throughout the plant.

It was recommended to substitute PVC conduit for the rigid steel type in the duct banks provided for the electrical distribution system. The PVC conduit would be of the type designed to be encased in concrete. Although the PVC does not have the resistance to crushing that galvanized conduit has, the concrete encasement would give the necessary physical protection to prevent damage.

Use Lower kV Insulated Cable

In the original concept 15 kV insulated cable was used for 4800 volt power feeders.

In the proposed concept, 8 kV insulated cable would be used for 4800 volt power feeders.

Reduce Number of Transformers at One Location

In one building, four separate transformers were used, each connected to the same 4160 volt system.

Consolidation into two transformers was proposed, along with conversion of the substation to a double-ended substation (connected to two separate 4160 volt systems). The change would decrease initial capital costs slightly, eliminate "common-mode failure", and provide increased operational flexibility.

Use Oil Filled Pad Mounted Transformers

The original system used 480 volt distribution transformers, 4160 volt-480Y/277 volt, 500 kVA, 3 phase 60 hertz dry indoor type. The efficiency for the dry type transformers is 97%.

The proposed concept recommended using oil filled, outdoor, transformers have an efficiency of 99% which results in operating cost savings as well as initial cost savings.

Cable Trays for Routing 15 KV Cable

Conventional rigid galvanized conduit was used for 15 kV cable, although cable trays were used for 480 volt power cable and 120 volt control cable, in the original design.

The proposed concept recommended using PVC jacketed, corrugated metallic sheathed cable for cable tray installation.

Substitute 480 Volt In-plant Electrical Distribution System for 4160V System

The original design utilized a 4160v "in-plant" distribution system. There was an incoming service switch gear lineup and 3 double-ended load center unit substations arranged for both primary and secondary selective service. These substations were to be double-ended units with the transformers having a dual primary rating of 4160V and 13.2 kV. New feeders in new underground ducts were proposed on the assumption that existing spare ducts were in a distressed condition. A second primary voltage of 13.2 kV was provided for future use.

A review of the total plant load after the proposed treatment plant addition revealed that the load would be too small for a 4160V system. The proposal recommended a 480 volt secondary selective distribution system using existing spare ducts to maximum capability on the assumption that they are in usable condition. A standby diesel generator was relocated closer to the 4160V entrance to the plant, to reduce required distribution facilities.

Replace Circuit Breakers with Fused Interruptor Switches

Originally, 15 kV power air circuit breakers were used for primary power distribution switchgear.

Fused interruptor switches were proposed as a substitute.

Modify Primary and Secondary Distribution Concepts

In the original design, primary electrical distribution was a dual-radial system with intermediate pad-mounted switching units. Secondary distribution was from outdoor power panels, with automatic switching through dual automatic transfer switches on the transformer secondarys.

The proposed concept recommended using a dual-loop system with sectionalized switch and fused primary selector switch. Primary feed would be to double-ended substations with secondary distribution at 480 V, 3 phase, 4W. Automatic tie breakers would be used on the 480 V system to provide uninterruptable power.

Material Change for Electrical Conduits

Conduit used for branch circuits and feeder circuits was galvanized rigid steel conduit in the original design.

The proposed concept recommended replacing the galvanized rigid steel conduit with Intermediate Metallic Conduit (IMC), which is accepted by the National Electric Code.

Use Load Interrupter Switches With Current Limiting Fuses

The original concept proposes to use 4.16 kV air circuit breakers.

The proposed concept uses 4.16 kV load interruptor switches with current limiting fuses.

Reduce Size of Feeder Cables MCC's

The original concept used parallel 500 MCM feeders for two motor control centers. These feeders had an ampacity of 760 A. The transformer would be rated at 300 VA with a full load current of 360 A.

The proposed concept would reduce the feeders to the motor control centers to parallel 250 MCM feeders, with an ampacity of 510 A. The voltage drop for this proposal would not exceed 1% of the rated system voltage.

Use Full Voltage Across the Line Starters

The original concept used 7200 volt, reduced voltage, primary reactor type starters for 2500 hp blower motors.

The proposed concept would use less complicated 7200 volt full voltage, across the line starters. The utility company permits starting of 2500 hp motors across the line.

General Power Distribution System Modification

The original concept provided two 15 kV breakers, four new load centers, one new 5 kV switch lineup, and the one line diagram shows 4.8 kV radial feed to each load center, and one 4.8 kV feeder to each pair of blowers.

In the proposed concept, two 15 kV breakers and one 750 kV load center would be deleted. The proposed one line diagram calls for a 4.8 kV radial feed to a group of two load centers and a 4.8 kV feeder to each blower and then ties a 480 volt secondary off-load center. The proposed power distribution system retains the same reliability as the original system.

Change in Conduit Material for Underground Distribution System

The original concept used a four-wire arrangement for distribution of 4160 voltage. The underground system was steel conduit in concrete, with a minimum conduit size of 3/4-inch

The proposed concept recommended using a delta three-wire arrangement, rather than the four-wire arrangement, and reducing the minimum conduit size from 3/4-inch to 1/2-inch.

Use of fiber conduit in concrete was also recommended in-lieu of the proposed steel conduit in concrete.

Use Intermediate Metallic Conduit in Place of Steel Conduit

In the proposed concept rigid steel conduit was utilized throughout the plant for the electrical wiring.

In the proposed concept intermediate metallic conduit would be substituted.

Use Owner Provided Transformer

In the original concept a 23,000-2400/4160V transformer was supplied and connected by the electrical utility company.

In the proposed concept the owner would supply, install, and maintain the transformer.

Use Intermediate Metal Conduit in Place of Rigid Galvanized Steel Conduit

The original concept specified rigid galvanized steel conduit and, 100% redundancy for transformers throughout the project.

The proposed concept suggested using intermediate metal conduit for all rigid galvanized steel conduit. It was also suggested eliminating the 100% redundancy in the transformers.

Add Dual Primary Feed for Air Compressors

A pure oxygen activated sludge plant was planned to utilize two 1000 HP air compressors, served by one motor control center and a single primary (4.16 kv) feeder.

The proposal recommended using individual motor controllers for each of the air compressors, and dual primary feeders for each motor controller. Overall reliability of the oxygen generation system would increase from this proposal although the initial cost would increase.

Add Power Factor Correction Capacitors to 10 HP or Greater Motors

The original concept had a low power factor as a result of using uncorrected squirrel cage induction motors.

The proposed change would add power correction capacitors of sufficient kVAR to all squirrel cage induction motors of 10 HP and above to provide a minimum power factor to be 0.95. Capacitors would be connected at the motors and not in a single capacitor bank.

Reduce Standby Power Capacity

The original design contained provisions for a 600 kw standby generator to operate during power failures.

Receiving stream quality required an EPA Reliability Class II Plant which requires generation capacity sufficient to provide treatment equivalent to sedimentation and disinfection. Several of the unit processes at the plant would not have to operate a power failure, which reduced the amount of standby power required from 600 kw to 200 kw.

Revise Specifications for 480v Motor Starters

The original concept specified motor starters having circuit protectors with current limiters rated at 100,000 amps interrupting capacity.

The proposed concept would delete the requirement for motor circuit protecters with current limiters on all 480 volt motor starters and use standard bus bracing with combination circuit breaker starters rated at 22,000 amps rms. The lower amp rating was determined thorugh a closer analysis of the maximum fault current.

Use Aluminum Conductors Instead of Copper

Copper conductors were originally specified for the MCC power feeder service.

The proposed concept recommended using 750 (MCM) aluminum conductors in place of the 500 MCM copper conductors, since aluminum to copper terminations could be specially designed to overcome the cold flow phenomenon in thermal expansion problems associated with aluminum. Also, the aluminum could be oversized to accomplish nearly equivalent current carrying capacity and nearly equivalent voltage drop limitations.

INSTRUMENTATION

Delete Indicating Lights

In the original concept the instrument main control panel had local/remote indicating lights provided for the motors with local/remote switches.

The proposed concept deletes the local/remote lights.

Eliminate Standby Computer

The plant was designed for computer control of major process functions. In case of failure of the computer, a standby computer was included in the original design.

Elimination of the second computer was proposed, with operation of the plant to be performed manually in the event of a computer malfunction.

Use Magnetic Flow Meters in Lieu of Parshall Flume

Under the original concept the plant effluent was metered using an existing Parshall flume, after the flow has passed through on existing chlorine contact chamber.

In the proposed concept a magnetic flow meter would be installed in the discharge of the raw wastewater pumps to meter the influent flow. A bypass would be constructed around the existing chlorine contact tanks and the existing Parshall flume. This proposal would provide a savings in headloss and reduce the head on the primary effluent pumps.

Eliminate Digester Gas Sampling System and Use a Laboratory Type Analysis

The original design for the anaerobic digesters included a methane sampling and analyzing system to measure digester gas methane content.

The proposed concept suggested eliminating the sampling system and using laboratory type analysis performed once every four or five hours to provide information on the quality and methane content of the digester gas since the original methane sampling system was not reliable due to the high moisture content of the digester methane off-gas. A gas analysis apparatus was already specified in the laboratory equipment and real time analysis of the methane content was not necessary for process control.

Eliminate One Chlorine Residual Analyzer and Two Sulfur Dioxide Mixers

In the original design, two separate analyzers were used for sulfur dioxide feed control and final effluent monitoring. The dechlorination system also included two mechanical sulfur dioxide mixers.

It was recommended that one chlorine residual analyzer be eliminated by alternating the function of the single analyzer between sulfur dioxide feed control and final effluent monitoring. The turbulence at the final effluent weir was used for sulfur dioxide mixing and eliminated the need for a mechanical mixer.

Replace Magnetic Flow Meters with Sonic Flow Meters

The original design included the use of 22 magnetic flow metering devices for all necessary process streams.

It was recommended that sonic flow meters be used in place of the magnetic flow meters.

Use Microprocessor Digital Controls at Local Control Panels

The original design used conventional analog controllers in the local control panels. Analog signals were transmitted to the computer and central control panel for monitoring only, with no operator remote control for processes.

The proposed concept recommended using microprocessor based digital controllers in the local panels in place of the electronic analog controllers. Data would be transmitted to the control building in digitized form via coaxial cables. The proposed digital data transmission system is less susceptible to noise and is more reliable.

Reduce Size of Central Control Panel

The initial design included a central control panel 30 feet in length used to display process variables and plant status using a graphic display, lights, and electronic indicators.

The proposed concept recommended reducing the size of the panel to 5 feet and using it to indicate critical variable and annunciate critical alarms in case the computer system is down. Cathode Ray Tube displays would be relied upon for graphic illustration of plant flow and other noncritical data.

Use Portable Sludge Blanket Level Detector in Place of Continuous Monitoring

In the original concept, continuous monitoring of the sludge blanket level in primary basins was used as an input to the primary sludge pump controls. In the proposed concept, the sludge blanket level control mode was eliminated and a portable sludge level detector was provided.

Delete Rate Controllers in Final Tank Drain Lines

In the original concept rate controllers were provided for the waste sludge lines from each final settling tank. These instruments controlled the rate of tank underflow from the final tanks to return sludge conduit. No provision was made for monitoring or controlling the rate of sludge wasted to sludge thickeners.

The proposed concept deleted the rate controllers on the final tank drain lines. Sludge underflow control would be by periodically opening and closing manual shutoff valves.

Eliminate "On-Off" Blower Operation for Dissolved Oxygen Control

The original concept controlled the dissolved oxygen (DO) in the aeration basin by turning the blowers on and off as required. Also, the control scheme included a timer to override the DO system.

The proposed control scheme recommended that the DO be adjusted by throttling the air suction lines to centrifugal blowers. The blowers would then run continuously and avoid excessive wear and tear on equipment. The two control schemes are shown in Figure 48.

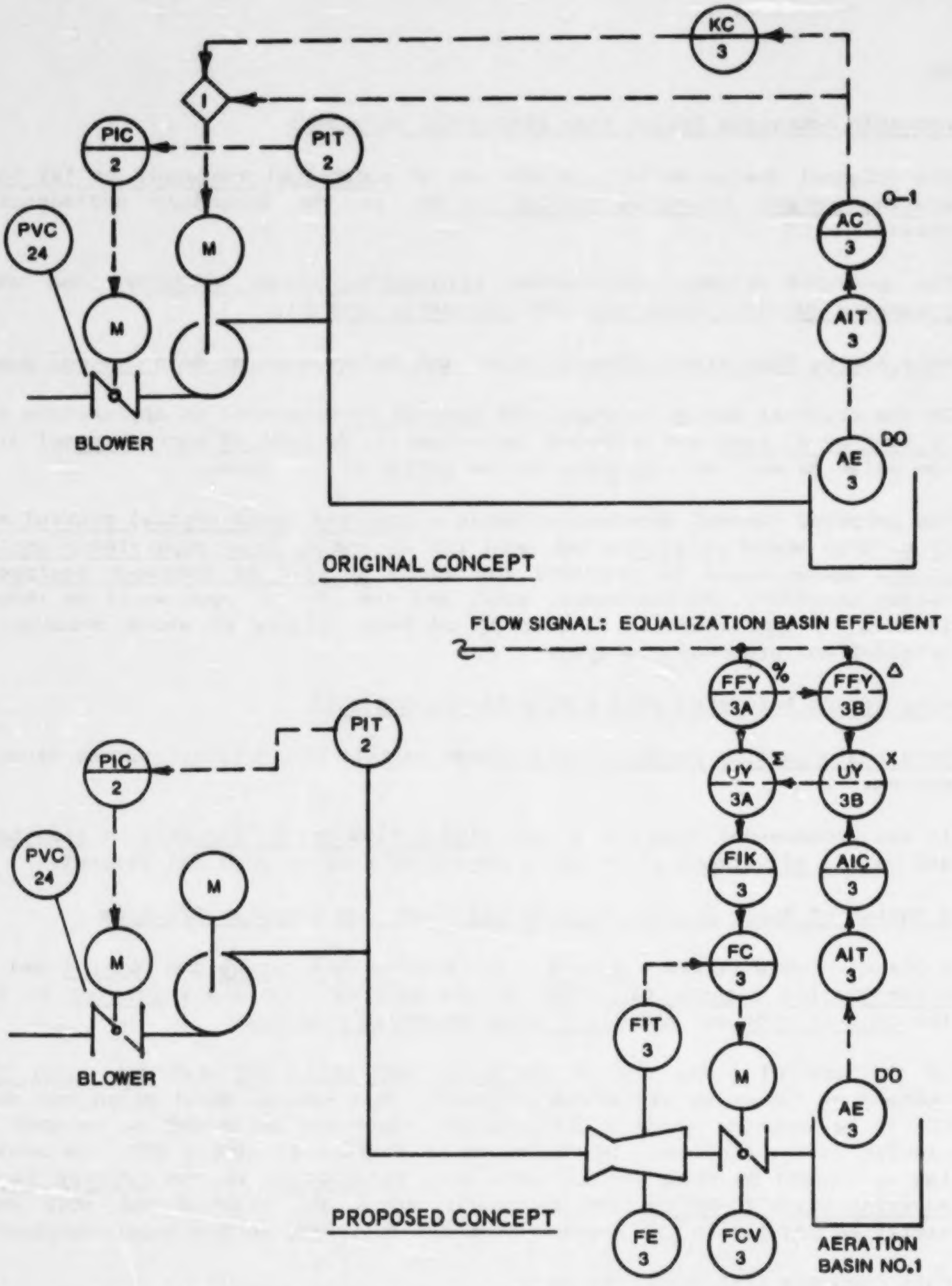

KC
3
PIC
2
PIT
2
AC
3
0–1
PVC
24
M
M
AIT
3
BLOWER
AE
3
DO
ORIGINAL CONCEPT
FLOW SIGNAL: EQUALIZATION BASIN EFFLUENT
FFY
3A
%
FFY
3B
Δ
PIT
2
PIC
2
UY
3A
Σ
UY
3B
X
PVC
24
FIK
3
AIC
3
M
M
FC
3
AIT
3
FIT
3
BLOWER
M
DO
AE
3
PROPOSED CONCEPT
FE
3
FCV
3
AERATION
BASIN NO.1

Figure 48. Dissolved oxygen control system.

CONTROL

Use Pneumatic Actuators Rather than Electrical Actuators

The original design called for the use of electrical actuators on 143 telescoping return activated sludge valves at the secondary sedimentation basins.

The proposed concept recommended eliminating these actuators and using pneumatic cylinder operators with pneumatic controls.

Eliminate Analog Supervisory Control Panel and Reduce Size of Main Control Room

In the original design concept, the control room covered an approximate area 32 feet by 35 feet and included approximately 92 feet of control panel along the walls as well as a console in the center of the room.

The proposed concept recommended using a computer based central control station. This would eliminate the need for an analog type supervisory control panel. Space would be provided for about 20 feet of computer equipment, backup recorders, multiplexers, etc., and the control room would be reduced in size to approximately 20 feet by 24 feet. Figure 49 shows sketches of original and proposed concepts.

Eliminate Return Activated Sludge Flow Pacing Controls

Return sludge flow pacing controls were part of the original sludge handling system.

It was recommended that the return sludge flow pacing controls be eliminated and manual adjustment of return sludge flow rate be provided instead.

Reduce Number of Color Graphic Cathode Ray Tubes and Computer Printers

A plant which utilized a computer for process monitoring and control had two color graphic Cathode Ray Tubes in the control room and a printer in both the control room and the plant superintendent's office.

In the control room, use of one black and white CRT and one color CRT, instead of two color CRT's was proposed. This change would allow the color CRT to be used for graphic data and the black and white CRT to be used for tabular data and alarms. In the event of failure of either CRT, the remaining one could be used for all purposes. Elimination of the printer in the superintendent's office was proposed, since all reports and logs could easily be printed in the control room and delivered to the superintendent.

Eliminate Computer Link With City Hall

A computer was planned for process monitoring and control of the treatment facility. A data link with city hall was also included to allow administrative officials to obtain process and maintenance information, as well as to perform general data processing.

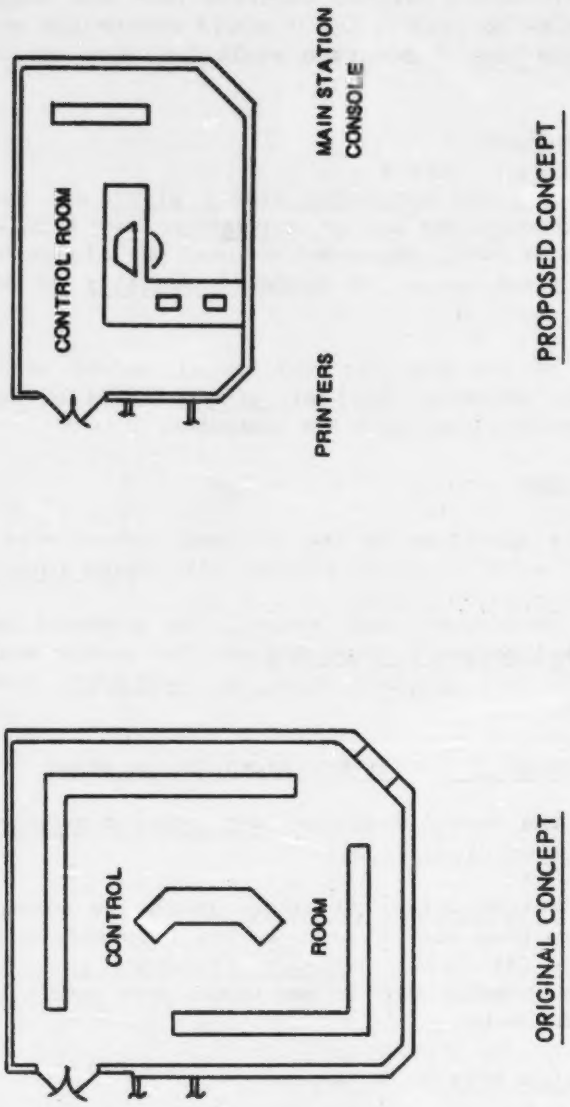

CONTROL ROOM
MAIN STATION
CONSOLE
PRINTERS
PROPOSED CONCEPT
CONTROL
ROOM
ORIGINAL CONCEPT

Figure 49. Reduce size of main control room.

Elimination of the data link to city hall was proposed. This proposal was based partly on cost of the data link, but more importantly, due to a greater chance of computer failure as the usage for data processing increased. If such a failure occurred when the computer was being used for data processing by city hall, it would reduce the overall reliability of the treatment facility. A separate small business computer was recommended for city hall.

Delete Computer Control

A 10.5 mgd, 2 stage activated sludge plant was designed to be completely controlled through the use of a computer and a variety of fixed monitoring probes, such as D.O., suspended solids, pH, sludge blanket depth, and liquid level. The plant could be operated manually in the event of a computer failure.

Elimination of the computer and manual and/or semi-automated operation of the plant was proposed. Portable probes would be used instead of the fixed monitoring probes used with the computer.

Change Pump Controls

Pump controls specified in the original design were simplex, variable speed control with solid state controller with wound rotor motors.

In order to save electrical energy, the proposed concept recommended using an adjustable frequency drive system. The system would lend itself to future expansion to the triplex mode of operation with minimal future cost expenditures.

Use Different Control on Return Activated Sludge Pumps

Originally, the design included eddy current couplings for speed control of return activated sludge pumps.

Because the return activated sludge pumps operated at low efficiencies, the energy consumption was very high. The proposed concept recommended using a single large (125 kVA) variable frequency parallel drive for all three pumps. The more efficient drives would save energy and offset the high cost of the drive system.

Replace Sluice Gates With Slide Gates

In the original concept, sluice gates were used for the aeration tank influent.

The proposed concept recommended replacing the sluice gates with slide gates.

Use One Sluice Gate in Place of Two

Two parallel sluice gates were originally provided to control flow in the chlorine tank influent channel and at the effluent pump station bypass.

The proposed concept recommended replacing each pair of sluice gates with a single gate of equal total area.

Use Manually Operated Sluice Gates in Place of Motor Operated Sluice Gates

The original concept proposed motor operated sluice gates at each screw pump. The function of each gate was to isolate an individual pump for maintenance and replacement.

The proposed concept recommended manual slide gates, since the gates would not be operated frequently.

Change Specification for Gate Valves

The original concept specified gate valves for sizes 2-1/2 inches and larger steam condensate and natural gas piping.

The proposed concept recommended using butterfly valves for gate valves greater than 2-1/2 inches.

Use a Single Weir in Place of a Double Weir

The original design for primary settling tanks includes an inboard, double weir, cast-in-place concrete effluent trough.

The proposed recommendation was to utilize an outboard, single weir, cast-in-place concrete trough.

Use Fiberglass Trough in Place of Concrete

The original concept for the circular primary clarifier provided an inboard, double weir, cast-in-place concrete effluent trough.

The alternate recommended was to use a fiberglass trough in lieu of the concrete.

Reduce Length of Splitter Weir

The original design concept included 8 ft long splitter weirs in a flow splitting structure.

In order to reduce the potential for settling of solids and to provide better low flow accuracy, the proposed concept suggested reducing the length of the weirs to 4 ft.

LIGHTING

Reduce Lighting Levels by 50%

The original concept utilized a combination of fluorescent, mercury vapor, and incandescent lighting.

The proposed concept recommended that the lighting level be reduced to the levels which approach the General Services Administration Energy Conservation Design Guideline. The reduction was to be accomplished by approximately a 50% reduction in foot candle levels, use of high pressure sodium or multivapor for high bay lighting, using less expensive fixtures or changing the types of fixtures, and by using a series lighting system for site lighting at 2400 volts.

Delete Lighting on Perimeter Road

Originally, the plant perimeter road was lit with sodium lights on 25' poles.

The proposal was to delete these fixtures on the plant perimeter road, and to only light the entrance road and the parking area.

General Use of High Pressure Sodium Lights

In the original concept, mercury vapor lights are used in high ceiling areas.

In the proposed concept, high pressure sodium lights would be used in the high ceiling areas. The high lumen output of high pressure sodium lights would require fewer fixtures and lower wattage for the same footcandle level lighting.

HVAC

Use an Amplified Heat Pump in Place of Electrical Resistance Heating for the Building

The original concept uses electrical resistance heating to heat buildings.

In the proposed concept an amplified heat pump with the final effluent as a heat source was substituted. The amplified heat pump could be used as the main source for heating the buildings since it can concentrate the heat from the final plant effluent to a temperature of about 160°F.

Delete Pneumatic Steam Control Valves

The original concept uses pneumatic steam control valves for the main zone steam lines.

The proposed concept would eliminate the pneumatic main zone steam control valve and manually close the isolating valves provided to shut down the steam main.

CHAPTER 7

ENERGY

ON-SITE GENERATION

Reduce Number of Standby Generators

A plant had a total connected load of 1500 kw, with 900 kw considered essential and 600 kw nonessential. Standby generations totaling 2250 kw (3 @ 750 kw) were planned to be installed. One of these standby generators served as a standby to the other two generators.

The proposed concept recommended installing emergency generation capacity for the essential load only. Two 900 kw generators were proposed.

Use Electric Cogeneration in Place of Flaring Excess Digester Gas

In the original concept the digester gas was utilized for gas engines and prime mover equipment. Any gas in excess of these requirements was flared as waste.

The proposed concept recommended using excess gas to generate electrical energy, with sale of this electrical energy to the power company supplying the plant.

Produce Mechanical Energy With Excess Digester Gas

Digester gas was planned to be used for digester heating, with excess gas used in an engine/generator combination to produce electrical energy for on-site usage. Cooling water from the natural gas engine would also be available for digester heating.

The proposed concept recommended using the excess gas in an engine which would directly drive other equipment, rather than driving a generator.

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HEAT RECOVERY

Use Digester Gas for Space Heating Boilers

The original concept used purchased natural gas to fire space heating boilers, while the excess digester gas was flared.

In the proposed concept excess digester gas would be used to fire the space heating boilers, with minimum purchases of natural gas.

Eliminate Engine Generators

In the initial design, two engine generators were used to convert digester gas to electricity. The generators were housed in an energy recovery building which had space for an additional future generator. Plant space heating was accomplished using natural gas.

The proposal recommended eliminating the engine generators and using the gas from the digester for space and process heating. This change reduced the size of the energy recovery building significantly, and provided more efficient use of digester gas since conversion to heat is much more efficient than conversion to electricity. The proposal eliminated the need for purchased natural gas.

Eliminate Heat Exchangers and Add Radiators

In the original design, ebullient cooling of the generator engines produced hot water which was pumped to five new heat exchangers to heat the digesters.

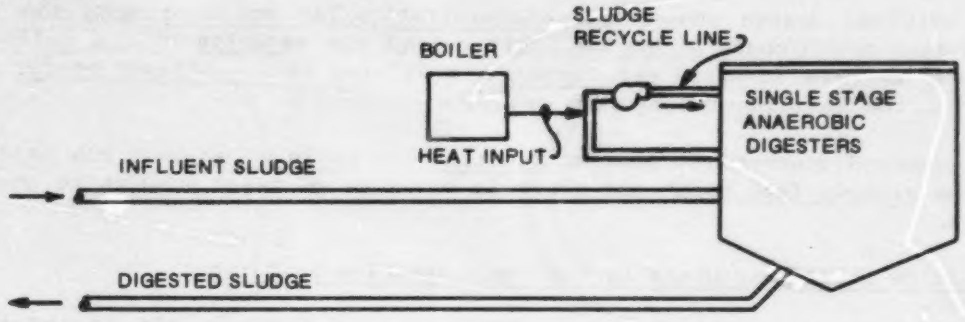
The proposed concept recommended eliminating the heat exchangers and using radiators on the generator.

The recommended change added two new boilers to produce steam for heating digesters. By installing radiators, it was possible to eliminate the top floor of the maintenance building.

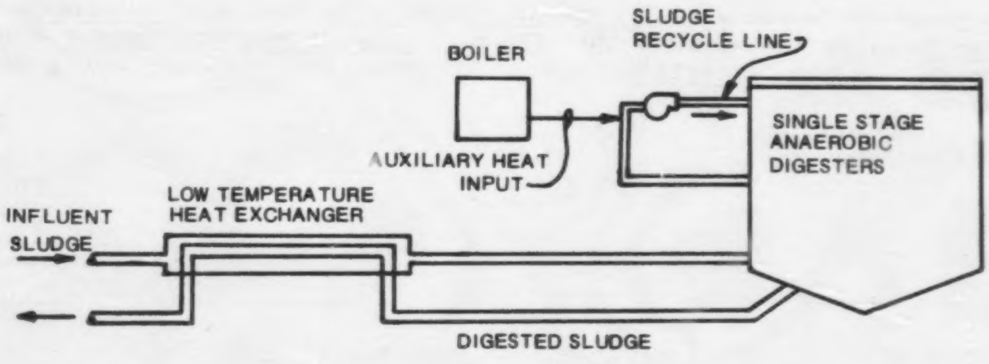
Install Heat Exchanger on Effluent Sludge Line

The original concept used anaerobic digestion for a combined stream of primary sludge and waste activated sludge. Digester heating was to be accomplished by an existing one million Btu unit and new units which are equivalent to one million Btu. The new units were staged with a low temperature exchanger preceeding the high temperature unit.

In the proposed concept a second low-temperature exchanger was added for preheating sludge. This heat exchanger was actually only a modification of the digester influent and effluent piping, in which the digester discharge would be passed through a 4" pipe located concentrically inside a pipe carrying the digester influent as shown in Figure 50. The procedure would allow recovery of 50% of the heat in the digester discharge.


SLUDGE
RECYCLE LINE
BOILER
SINGLE STAGE
ANAEROBIC
DIGESTERS
HEAT INPUT
INFLUENT SLUDGE
DIGESTED SLUDGE

ORIGINAL CONCEPT


SLUDGE
RECYCLE LINE
BOILER
SINGLE STAGE
ANAEROBIC
DIGESTERS
AUXILIARY HEAT
INPUT
LOW TEMPERATURE
HEAT EXCHANGER
INFLUENT
SLUDGE
DIGESTED SLUDGE

PROPOSED CONCEPT

Figure 50. Install heat exchanger on effluent sludge line.

CONSERVATION

Rotate Administration Building 90°

The original design showed the administration/lab building with the long axis in a north/south direction. This caused the majority of the walls and windows to have an east/west exposure, resulting in significant energy cost to cool the building during warm weather.

The proposed concept recommended rotating the building so that the majority of the windows face north and south in order to decrease summertime cooling costs.

Use Reflective Insulating Glass in the Administration Building

The glass in the adminstration building covered is about 15% of the total area on 2 sides of the building. The original design concept used regular plate glass for these windows.

The proposal suggested using reflective insulating glass in place of regular glass. The proposal resulted in an increased initial cost, but reduced cooling and heating requirements over the life of the building.

Extended Pump Discharge Pipe Below Water Surface

The original design included an intermediate pumping station to lift primary effluent to the aeration basins. The pumping station consisted of vertical turbine pumps discharging into the top of a channel.

The proposed design extended the discharge pipe from each pump below the water level in the channel. The effective pumping head was thereby reduced through a siphoning effect. Figure 51 shows the original and proposed designs.

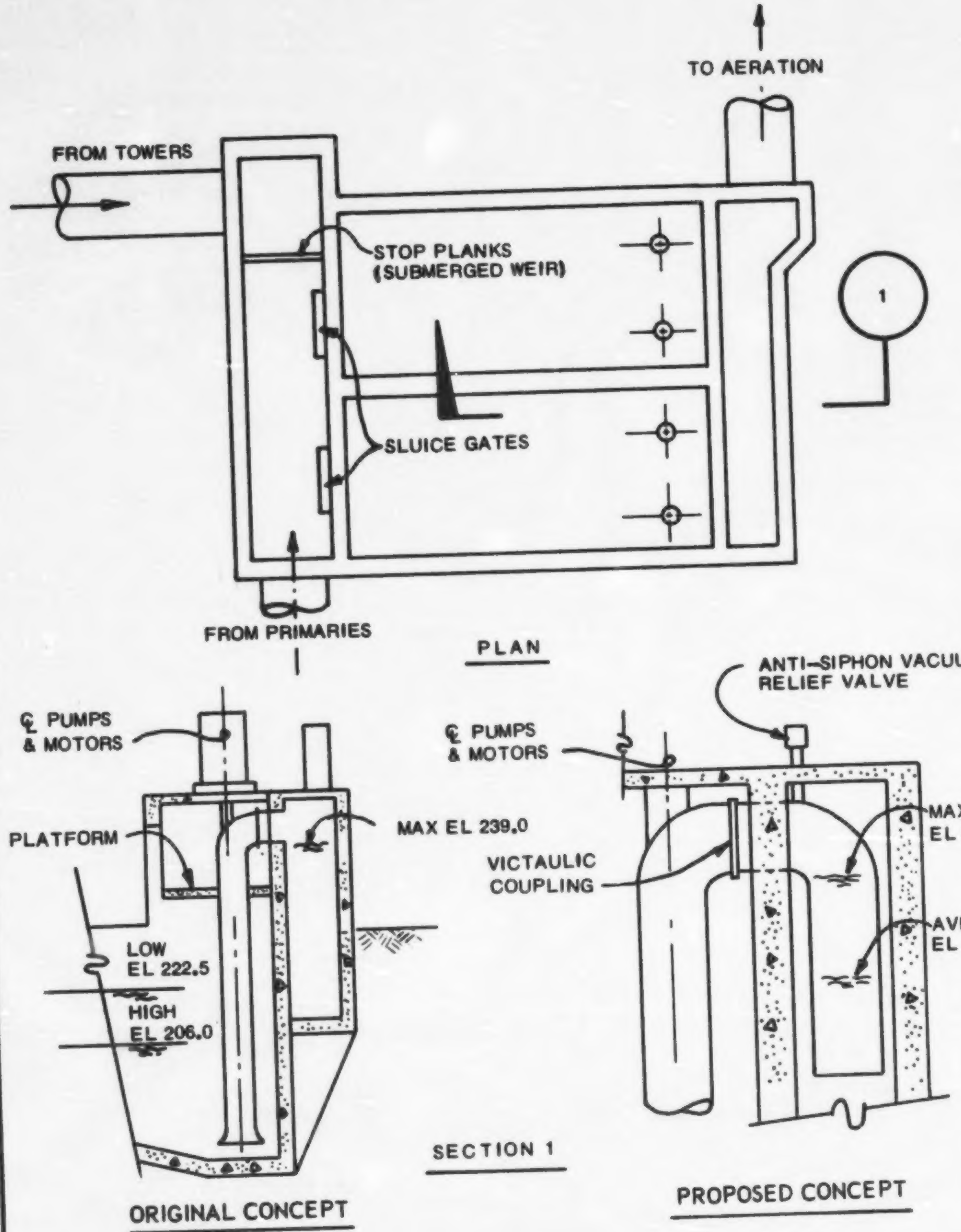

TO AERATION
FROM TOWERS
STOP PLANKS
(SUBMERGED WEIR)
SLUICE GATES
1
FROM PRIMARIES
PLAN
ANTI-SIPHON VACUUM
RELIEF VALVE
℄ PUMPS
& MOTORS
PLATFORM
MAX EL 239.0
LOW
EL 222.5
HIGH
EL 206.0
℄ PUMPS
& MOTORS
VICTAULIC
COUPLING
MAX
EL 239.0
AVERAGE
EL 233
SECTION 1
ORIGINAL CONCEPT
PROPOSED CONCEPT

Figure 51. Extended pump discharge pipe below water surface.

CHAPTER 8
AESTHETICS

ODOR CONTROL

Reverse Air Flow Through Trickling Filters

Since odor control at the treatment facility was an important consideration, domed covers over trickling filters were included in the original concept. Scrubbers were planned to remove and deodorize air which collected under the dome covering.

Reversal of "normal" air flow through the trickling filters was proposed in conjunction with elimination of the domes over the trickling filters. The scrubbers used in the original concept would be connected through air ducts to the under/flume area of the trickling filter, pulling air downward through the trickling filter and then deodorizing it. A localized deodorant system was proposed for masking minor odors.

Revise Odor Control System

The original concept used ozone for odor control of air from the headworks building, where odor emanated from both the raw wastewater and septage delivered to the plant. Since heating requirements for the headworks building were 34,000 CFM, the ozone deodorization system was sized for 34,000 CFM.

In the proposed concept, the headworks was divided into separate areas for the septage and sewage to allow individual control of odor from each source. This change was made because over half the odor was attributed to the septage. In the proposal, activated carbon was used to treat the more concentrated odor from the headworks area, with the system sized for 100 CFM, and only intermittent operation required. The ozone system for the headworks area was in turn reduced to 17,000 CFM, as was the heating system.

Hydrogen Peroxide Injection Into Wastewater Flow

Odor control was a key concern at an existing plant, and extensive measures were included in the original design for its control. The key odor control measures consisted of covering the major process units and using odor control scrubbers for the air contents.

Injection of hydrogen peroxide into the wastewater stream at several points was proposed in lieu of the original concept of covering basins and using air scrubbers. Since success of this concept could not be assured, it was recommended that the owner conduct a two-week pilot study to evaluate the effectiveness of the proposal.

Use Activated Carbon Odor Control System

In the original concept the odor control system employed chemical wet scrubbers.

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In the proposed concept, in the low odor potential area, carbon scrubbers were used instead of wet chemical scrubbers.

Eliminate Covers on Standby Aerobic Digesters

In the original concept, standby aerobic digesters, preaeration tanks, and aerated grit tanks all had covers made from aluminum panels. Air was to be withdrawn from under the covers and scrubbed for odor control.

In the proposed concept, no covers would be used on the standby aerobic digesters, but the covers were retained on the preaeration and aerated grit tanks.

Use Scrubbers Ahead of Carbon in High Odor Areas

In the original concept, activated carbon was used to scrub air as an odor control measure.

In the proposed concept, in the high odor potential areas, the air would be pretreated using a chemical scrubber ahead of the carbon, thus reducing the amount of activated carbon regeneration required.

Recycle Air Thru Aerated Channels for Odor Control

In the original concept, odor control was accomplished by hydrogen peroxide addition to the plant influent, chemical scrubbing of air from under the primary clarifier covers, and aeration of the channel between the primary clarifiers and the aeration basins. Eight separate chemical scrubbers were used for air from under the aeration basin covers.

The proposed concept recommended using the air collected at the primary clarifiers as suction air for supply to the channel blowers.

Eliminate Biological Odor Reduction Tower and Use Two-Stage Carbon

The original design included a two-stage odor removal scheme employed at two locations: 1) the headworks building for treating odors from primary and headwork facilities, and 2) energy solids building for treating solids handling odors. The scheme included a biological odor removal tower followed by activated carbon adsorption with an inner stage blower for driving air flow. The biological odor control tower operated by blowing foul air into the bottom of the tower, and spraying secondary effluent on the top surface of the tower.

The proposed concept recommended utilizing the two-stage odor removal scheme in the same locations, but eliminating the biological stage. The recommended design therefore employed a two-stage activated carbon system (considered to be more effective and reliable) and required the blower capacity to be increased proportional to the increased system pressure drop. Figure 52 shows sketches of the original and proposed concepts.

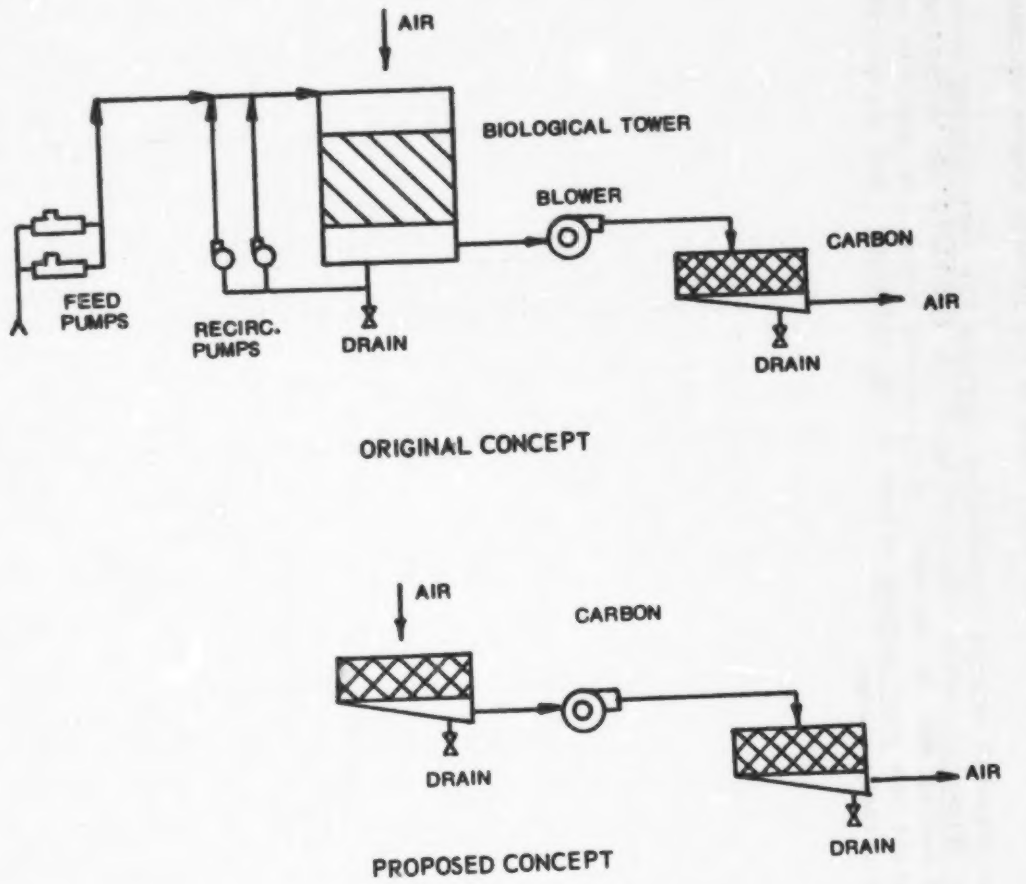

AIR
BIOLOGICAL TOWER
BLOWER
CARBON
AIR
FEED PUMPS
RECIRC. PUMPS
DRAIN
DRAIN
ORIGINAL CONCEPT
AIR
CARBON
DRAIN
AIR
DRAIN
PROPOSED CONCEPT

Figure 52. Use two-stage carbon for odor control.

Delete Odor Control from Waste Activated Sludge Thickener

The original odor control system included a counter flow packed tower utilizing sodium hypochlorite as the oxident. Two gravity thickeners were arranged such that either thickener could be used as the waste activated sludge thickener and the other used as the primary sludge thickener.

The proposed concept recommended deleting the odor control system from the WAS thickener, since offensive odors are generally not emitted when gravity thickening WAS. To implement the proposed change, it would be necessary to install the odor control system on one thickener, and using that thickener for primary sludge.

NOISE CONTROL

Use Sound Absorbing Enclosures to Trap Sound at the Source

In the original concept the blower building is clad with sound absorbing materials, i.e. "sound blox", hung ceiling, and perforated metal panels to reduce the noise level due to blowers and motors.

In the proposed concept, blowers and motors would be partially enclosed in sound absorbing enclosures which trap sound at the source, and eliminates the need for other acoustical treatment.

ARCHITECTURAL

Eliminate Brick Cover on Columns in Headworks

The original concept provided a headworks building with 26 interior columns. The columns are encased in concrete and faced with brick.

In the proposed concept the brick facing was eliminated on all 26 columns.

Delete Brick Paver on Ramp to Administration Building

The original concept for the administration building indicated a brick paver on the ramp for the entrance to the building as well as the stairway and other outside entrance areas.

The proposed concept would eliminate the pavers from the entrance ramp, outside areas of the building, and on the entrance wall. Brick on the ramp would be hazardous to handicapped people.

Delete Rubbed Finish for Concrete

The original concept required all concrete surfaces built against forms which would normally be exposed to view, to be given a rubbed finish after patching tieholes, voids, honeycombs, and broken edges.

The proposed concept would eliminate the final rubbed finish. Within the proposed concept, the concrete would be finished as above except that the final rubbing would be deleted. This would be a "smooth form finish" per ACI 301, "Suggested Specifications for Structural Concrete Buildings."

Delete Painting

The original concept painted most of the concrete floors, walls, ceilings and stairs.

The proposed concept recommended eliminating all painting of interior and submerged concrete.

Use Surface Treatment of Concrete Block in Place of Stone Facing

The original concept used stone facing on concrete block.

The proposed concept would eliminate the stone facing and surface treat the concrete block to create a pleasing effect.

Epoxy Finish in Place of Glazed Block

The original concept used glazed block for construction of the filter building.

The proposed concept would use standard block with an epoxy finish. The new epoxy finishes should be equal to the glazed blocks and the building joints would be sealed.

Use Textured Block in Place of Stone Veneer

The original concept used stone veneer over construction block.

The proposed concept recommended a textured block in place of the stone veneer.

Delete Paint on Floors

In the original concept, painted floors were used in the headworks, solid buildings, filter areas, garage, chemical buildings and pump station.

In the proposed concept the floor surfaces would not be painted.

Use Stainless Steel Instead of Aluminum

The original concept used aluminum handrails around open process facilities. Since the proposed treatment facility was near the ocean.

Substitution of stainless steel handrails for the aluminum handrails was proposed. The service life was estimated to be 20 years for the stainless steel and 10 years for the aluminum.

Use Fiberglass Handrail and Grating

The original concept proposed aluminum handrail around the aeration tanks, rapid mix tank, grit chamber, screen pumps, in the process building, and around the sand filters.

The proposed concept substitutes fiberglass handrails in place of the aluminum handrail and fiberglass grating in place of aluminum grating. (Adequate safeguards for quality control and proper pigmentation to prevent ultraviolet radiation deterioration were to be provided.)

Use Concrete Handrails

The original design of the treatment facility included anodized metal handrails outside primary clarifier basins, aeration tanks, sludge equalization area, and chlorine contact basins.

The proposed concept recommended using a concrete wall 4-inches thick and 3-1/2 feet high in the same areas.

NOISE CONTROL

Use Sound Absorbing Enclosures to Trap Sound at the Source

In the original concept the blower building is clad with sound absorbing materials, i.e. "sound blox", hung ceiling, and perforated metal panels to reduce the noise level due to blowers and motors.

In the proposed concept, blowers and motors would be partially enclosed in sound absorbing enclosures which trap sound at the source, and eliminates the need for other acoustical treatment.

CHAPTER 9

CONSTRUCTIBILITY

STRUCTURAL DETAILS

Use Wall Strut System in Place of Cantilever Walls

In the original concept, four second-stage aeration basins were built with common walls. The interior walls were designed battered (tapered) and the exterior walls were designed unbattered. All walls were built in a cantilever fashion with reinforced concrete.

In the proposed concept all walls would be built unbattered with compression struts installed at the top of the walls for strength. The struts would be placed at 30 foot intervals. Figure 53 shows sketches of the original and proposed concepts.

Eliminate Peripheral Concrete Walkway on Trickling Filters

In the original design, the trickling filter wall were built with double-tie, precast concrete members set vertically in a circle capped by a poured-in-place concrete ring. The concrete ring would resist hoop tension from the ends of the double-tee members, serve as a 3 ft wide walkway around the filter, compensate for unevenness in the top of the double tee members, and provide stiffness.

The proposal recommended redesigning the filter with a 26" wide concrete stiffening ring around 3/4 of the filter circumference, and the remaining 1/4 of the circumference a 36" walkway with handrail. The proposal would reduce costs and still provide solid footing around 1/4 of the filter periphery to manually rotate the distributor arms.

Revised Pile Specifications

The original concept provided pile specifications with a driving point on "H" piles, load test for twice the required bearing capacity, and twice the required uplift capacity.

The proposed concept recommended revising the requirements to delete the driving points for "H" piles which have cut off elevations below the fill layer, and a reduction in the test uplift capacity to 1-1/2 times the design.

Use Common Wall for First and Second-Stage Aeration Basin

Originally, the first and second-stage aeration basins were parallel to each other, but did not use common wall construction.

It was proposed to relocate the second stage adjacent to the first stage, and eliminate one of the original walls.

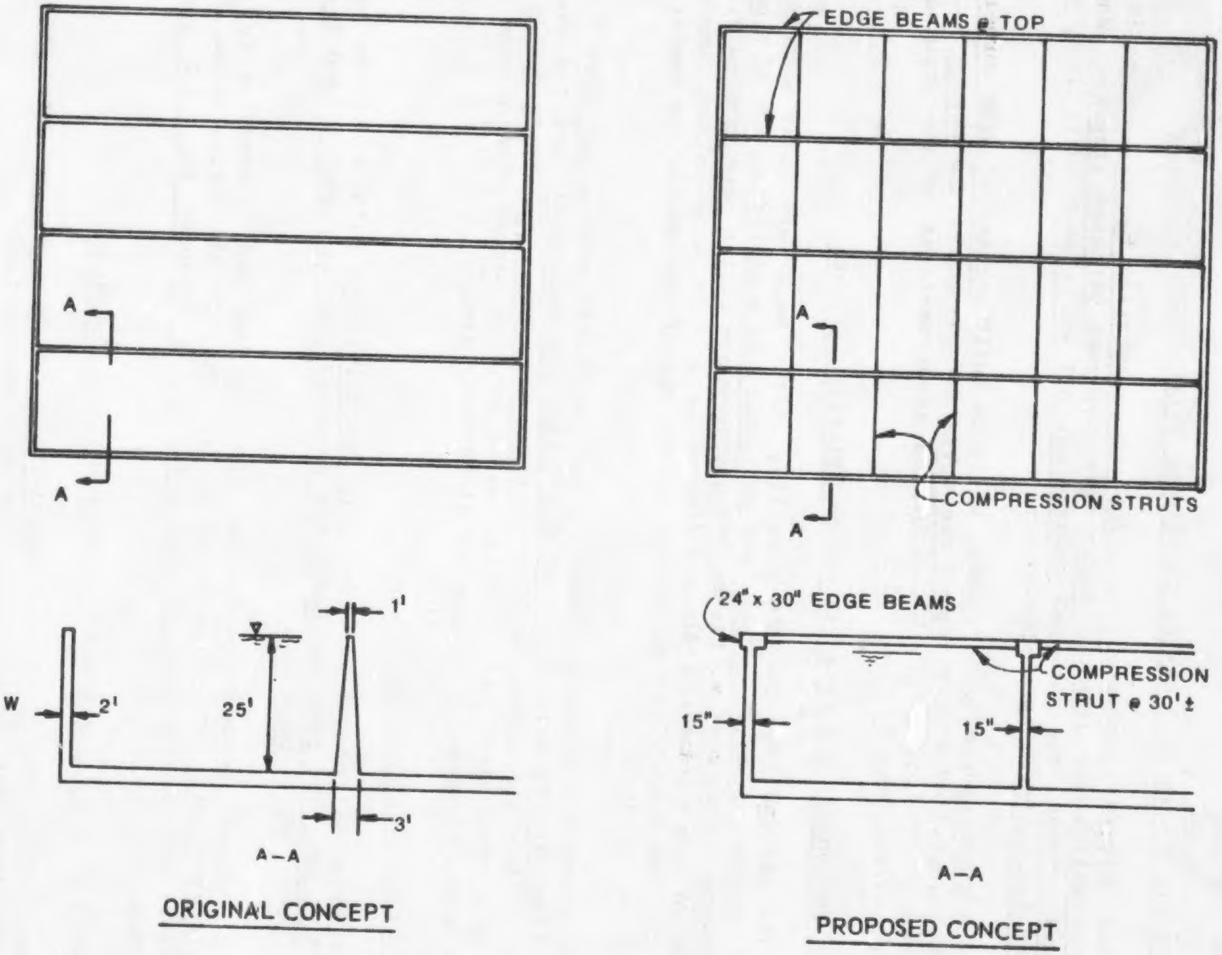

EDGE BEAMS @ TOP
A
A
A
A
COMPRESSION STRUTS
W
2'
25'
1'
3'
A–A
ORIGINAL CONCEPT
24" x 30" EDGE BEAMS
COMPRESSION
STRUT @ 30'±
15"
15"
A–A
PROPOSED CONCEPT

Figure 53. Wall strut system.

Eliminate Fillets

Aeration tanks were designed with fillets in the bottom sides and ends of the basins.

Elimination of these fillets was proposed, since they serve no useful function.

Simplify Concrete Form Work

In the original design, the activated sludge tanks consisted of concrete walls with haunches and corbels.

The proposed concept recommended eliminating the haunches and corbels in order to simplifv the concrete work and reduce the initial cost.

Use Straight Walls with Minimal Fillets in Place of Complex Slanted Walls in Aeration Basins

In the original concept the aeration tank used slanted walls which required complex and involved forming.

The proposed concept would use straight walls with minimal fillets in the bottom corners between walls and floors.

CONSTRUCTION SEQUENCING

Eliminate Installation of Equipment for Future Design Flows

The pretreatment facilities included raw influent pumping and grit tanks. These facilities were sized for the ultimate flow rate which was twice the initial design flow rate. In addition, process equipment for these facilities was sized to provide treatment for the ultimate flow. The process equipment included raw sewage influent pumps, mechanically cleaned bar screens, and grit collectors.

In the proposed concept, any equipment not required for the initial design rate would be eliminated.

Relocate Operations and Laboratory Building and Thus Eliminate Temporary Housing

In the original concept temporary laboratory facilities and offices were required while the existing structure was demolished and reconstruction on the same site.

In the proposed concept, a new location was chosen for construction of the new facility, thereby eliminating the temporary operations laboratory and plant control. After construction of the new facility the original structure would be utilized for storage.

Build Primary Clarifiers Before Flow Equalization Basin

The original design required flow equalization basins during Phase I of the project. Primary clarifiers were to be constructed five years later during Phase II.

The proposed concept recommended constructing the primary clarifiers during Phase I and defer the flow equalization basins to Phase II. The primary clarifier, would be used to equalize flow between Phase I and Phase II.

MATERIALS

Use PVC Pipe for Polymer Piping in Place of Stainless Steel

In the original concept, the polymer transport piping was stainless steel.

In the proposed concept, PVC pipe with solvent weld fittings would be substituted for polymer piping.

Use Steel Framing

The original concept used cast-in-place concrete to be used for floor and roof construction.

The proposed concept recommended using steel framing with metal decking. Figure 54 shows sketches of the original and proposed concepts.

Substitute Fiberglas Grating for Aluminum Grating

Since the treatment facility was located in a coastal area with high corrosion rates, the original design specified aluminum gratings.

Fiberglass gratings were proposed as a substitute for the aluminum grating. The fiberglass gratings would be constructed of fire resistant, reinforced, polyester. The fiberglass gratings would have a 20-year life versus a 10-year life for the aluminum gratings.

Use Concrete-Lined Channel in Place of Reinforced Concrete Pressure Pipe for Outfall Line

The original concept proposed using a concrete pressure pipe for the outfall line.

The proposed concept recommended a concrete lined channel in place of the pressure pipe.

Use Corrugated Steel Pipe in Place of Reinforced Concrete Pressue Pipe for Outfall Line

The original concept proposed reinforced concrete pressure pipe for the outfall line.

The proposed concept recommended corrugated steel pipe as an alternative. The pipe would be lined with a bituminous coating.

Use Fly Ash as Fill for New Construction

The original concept used sand and gravel for fill in the construction of the plant.

The proposed concept suggested using fly ash from the incinerator ash lagoons in place of sand and gravel.

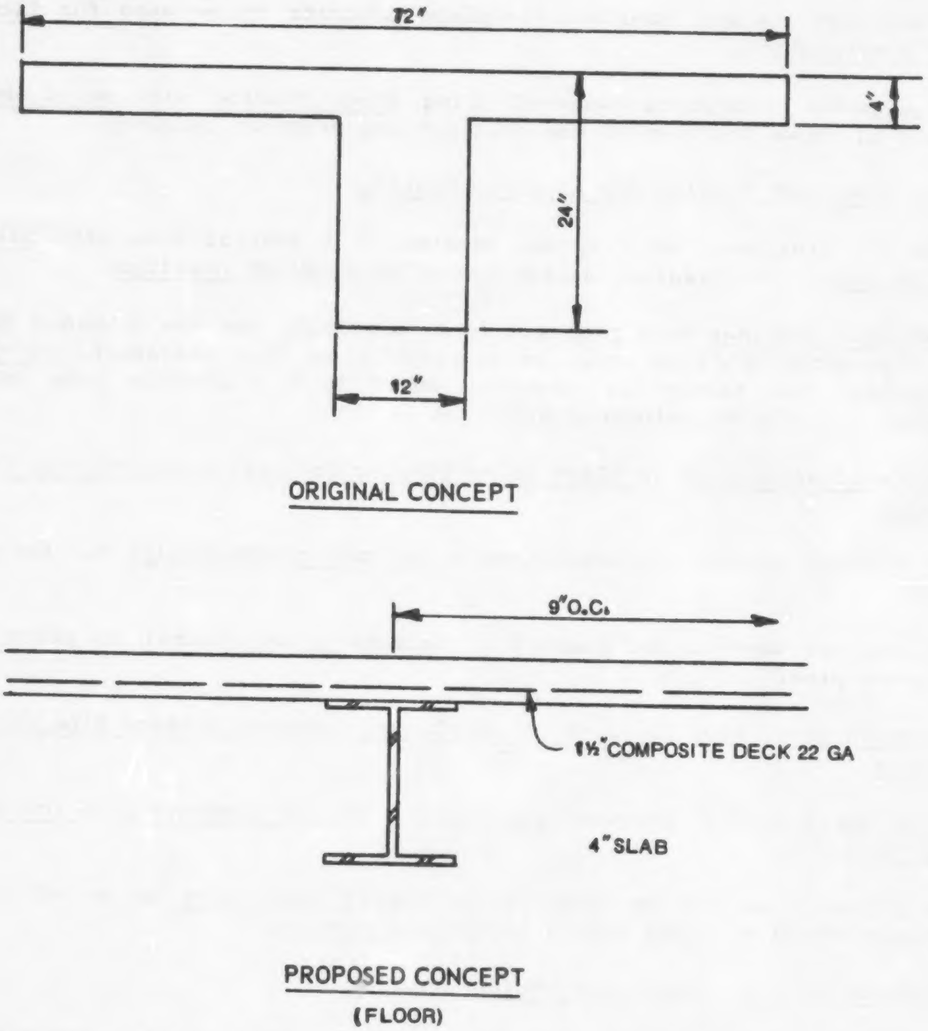

72"
4"
24"
12"
ORIGINAL CONCEPT
9" O.C.
1½" COMPOSITE DECK 22 GA
4" SLAB
PROPOSED CONCEPT
(FLOOR)

Figure 54. Use steel framing.

"Shotcrete" Fixed Cover on Anaerobic Digester

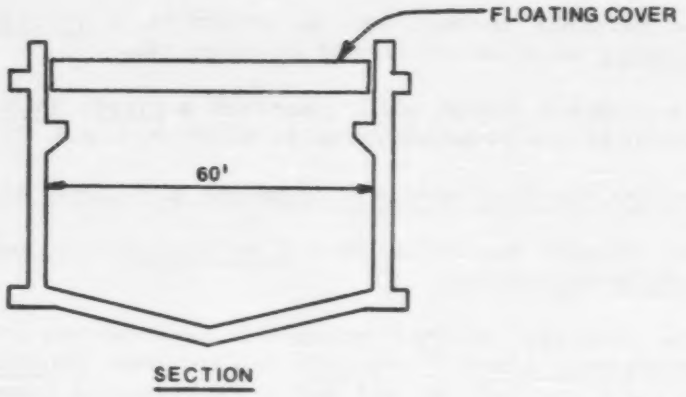
The original concept was to construct a floating cover on the primary digester to allow storage of digester gas.

The proposed change would construct a fixed, insulated "shotcrete" cover. A sketch of the proposed cover is shown in Figure 55.

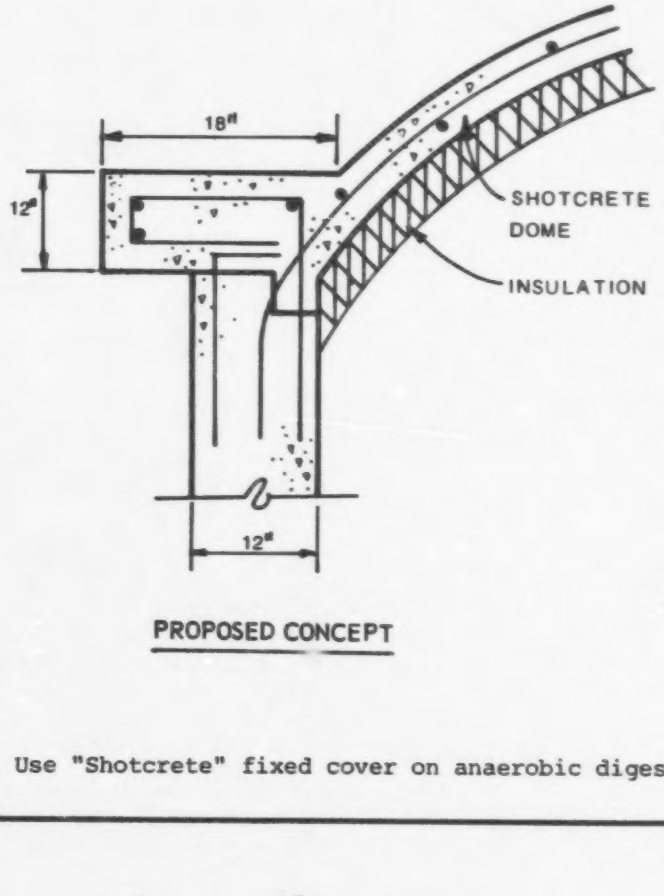
Replace Concrete Flow Equalization Basins With Lined Earthen Basins

The original design included flow equalization basins constructed of formed reinforced concrete.

The proposed concept suggested constructing the basins with earthern embankments lined with gunite applied over reinforced steel. An alternative to the first proposal was earthen embankments lined with "Hypalon".


FLOATING COVER
60'
SECTION

ORIGINAL CONCEPT


18"
12"
SHOTCRETE DOME
INSULATION
12"

PROPOSED CONCEPT

Figure 55. Use "Shotcrete" fixed cover on anaerobic digester.

CHAPTER 10

SEWERS

MANHOLES

Modify Method of Construction

In the original design, manholes for a 54 inch interceptor were either 8 ft diameter precast units or 9 ft diameter mansonry units with top and bottom concrete slabs and grouted inverts. Standard 4 ft diameter precast risers were to be used to extend from the top slab to ground level.

The proposal recommended using tee-style manholes consisting of a 12 ft length of the 54-inch sewer pipe placed on end and supported on the 54-inch interceptor, with an access slot (18" x 48") cut in the top of the interceptor 54-inch pipe were proposed. Standard 4 ft diameter precast risers grouted to the top of the pipe of the 54-inch pipe standing on end would also be used. A plain concrete mat beneath the section of pipe containing the manhole would be required for support. Alignment changes in the interceptor would be made with a pipe bend ahead or behind the 12 ft length of pipe containing the manhole.

Replace Cast-in-Place Manhole With Precast Manhole

In the original design, the interceptor used cast-in-place manholes.

The proposal recommended substituting precast manhole sections for cast-in-place manholes.

GENERAL CONSTRUCTION

Eliminate Alignment Holes for Control of Line and Grade

The original design required alignment/grade check holes along with pipeline route.

The proposed concept recommended deleting the requirement for check holes. The construction of the holes would be optimal for the contractor.

CHAPTER 11

INTERCEPTOR SYSTEM PUMPING STATIONS

STRUCTURE

Change Roof Deck From Wood Truss to Precast Concrete

The original roof deck design consisted of wood trusses with a plywood roof deck and soffitt framing. One pumping station used metal roofing and another used asphalt shingles which would blend with the surrounding buildings.

Precast concrete roof decks were proposed because of their lower cost, longer life, ability of supporting a monorail hoist, and resistance to fire. The proposed decks would be covered with 2-inch of lightweight concrete fill and a 5-ply tar and gravel roof.

Change Design Method and Use Grade 60 Reinforcing

The original design utilized the "Alternate Design Method," also known as working stress design, and Grade 40 reinforcing.

The proposed concept recommended that the structure be designed for restricted crack width, which allowed the use of higher flexural reinforcing stresses. Grade 60 steel would be used in the proposed change.

Reduce Structure Size due to Piping Revisions

In the original design, the pump discharged to the bottom of a common header.

The proposed concept recommended relocating the discharge to the side of the common header instead of the bottom. Although there was little overall savings in piping costs by the proposed change, the pump stations would be several feet shorter in length and width and the overall pump station depth would be decreased about two feet. The depth was significant because of the prevailing high groundwater conditions.

EMERGENCY GENERATOR

Reduce Size of Emergency Generator

The original design sized a standby generator for ultimate pumping station capacity of three pumps.

The proposed concept recommended reducing the generator capacity to the two pumps which would be required initially since the third pump would not be required until about 40 years in the future.

PIPING

Piping Modifications

The original design utilized a discharge gate and check valves on each pump. On the force main leaving the pumping station, gear operated gate valves were used on each side of the control valve.

The proposed concept recommended using DeZurik eccentric plug valves as a substitute for the gate valve and the check valve and knife gate valves rather than the gear operated gate valves for isolation of the control valve on the effluent force main.

Use Force Main Instead of Gravity Interceptor

Two gravity interceptors were tributary to the plant's influent raw wastewater pumping station. One interceptor had a pumping station some distance upstream.

A proposal was recommended increasing the pumping head on the upstream pump station and converting the interceptor to a force main which would convey flow directly to the plant headworks, bypassing the on-site raw wastewater pumping station. The other interceptor still required an on-site raw wastewater pumping station, but the pumping station was now considerably smaller in capacity. Figure 56 shows a schematic of the original and proposed systems.

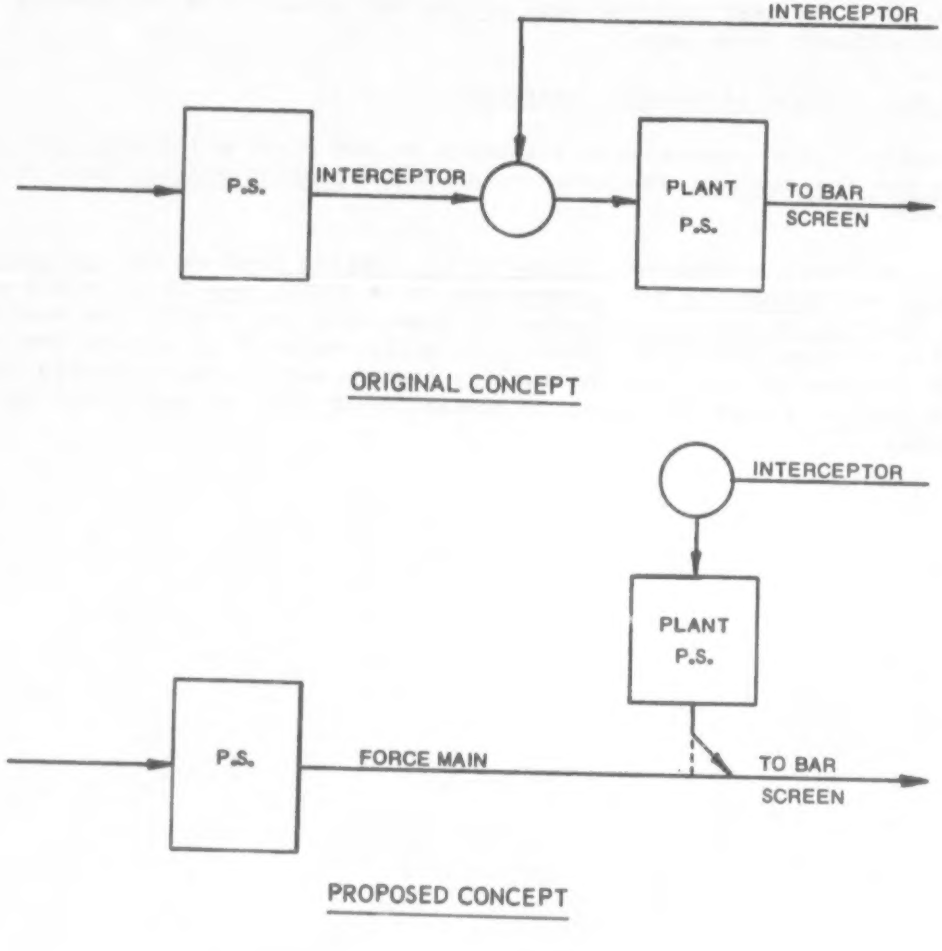

INTERCEPTOR
P.S.
INTERCEPTOR
PLANT
P.S.
TO BAR
SCREEN
ORIGINAL CONCEPT
INTERCEPTOR
PLANT
P.S.
P.S.
FORCE MAIN
TO BAR
SCREEN
PROPOSED CONCEPT

Figure 56. Use force main instead of gravity interceptor.

DESIGN CONCEPT

Replace Electric Motors with Diesel Drive

A pumping station was required during periods of heavy precipitation, to pump flows which exceeded the treatment facility capacity into a storage pond for subsequent treatment. The pumping station would be utilized about 3% of the time. The original concept used 4 (1 as standby) pumps, each driven by an induction motor and each having on-off control. Diesel engine generator sets were planned for power generation for the electric motors, as well as for plant standby power requirements.

The proposal was to eliminate the induction motors and utilize diesel engines to drive the pumps directly. The standby pump was eliminated, and only 3 pumps were used in the proposed design. The diesel engine on one of the pumps was also proposed to drive a standby generator for other plant requirements.

CHAPTER 12

OCEAN OUTFALL

COVERING MATERIAL

Eliminate "Armor Rock" Covering

In the original design, a 36-inch ocean outfall was covered with a 5-inch thickness of "Hevicote" and then to be further covered by 9-inch to 12-inch rocks. Then, a several foot thick layer of "Armor Rock" was to be added for additional weight and protection. The top of the "Armor Rock" was to be 2 feet deeper than the expected limit of erosion of the ocean floor.

The proposed concept recommended elimination of the "Armor Rock" covering, since the 5-inch Hevicote and the layer of 9-inch to 12-inch rocks would provide sufficient protection and weight. No change was proposed for the depth of the outfall below the ocean floor. Figure 57 shows sketches of the original and proposed concepts.

Use Hold Down Piles in Place of Rock Cover

In the original, a layer of rock and a layer of "Armor Rock" would cover for the outfall pipe.

The proposed concept recommended eliminating both layers of rock covering and anchor the outfall to 2 pile bents at 40 ft intervals using pile caps and hold down strips. Figure 58 shows sketches of the original and proposed concepts.

Reduce Cover Over Outfall by 2 ft

The original design included one foot of 9-inch to 12-inch rocks over a 36-inch diameter ocean outfall, with an additional 2 to 3 foot layer of 12-inch "Armor Rocks." The top of the "Armor Rock" was planned to be 2 ft below the expected limit of erosion of the ocean floor.

The proposed concept recommended that the outfall be raised two feet, placing the expected limit of erosion at the surface of the layer of "Armor Rock."

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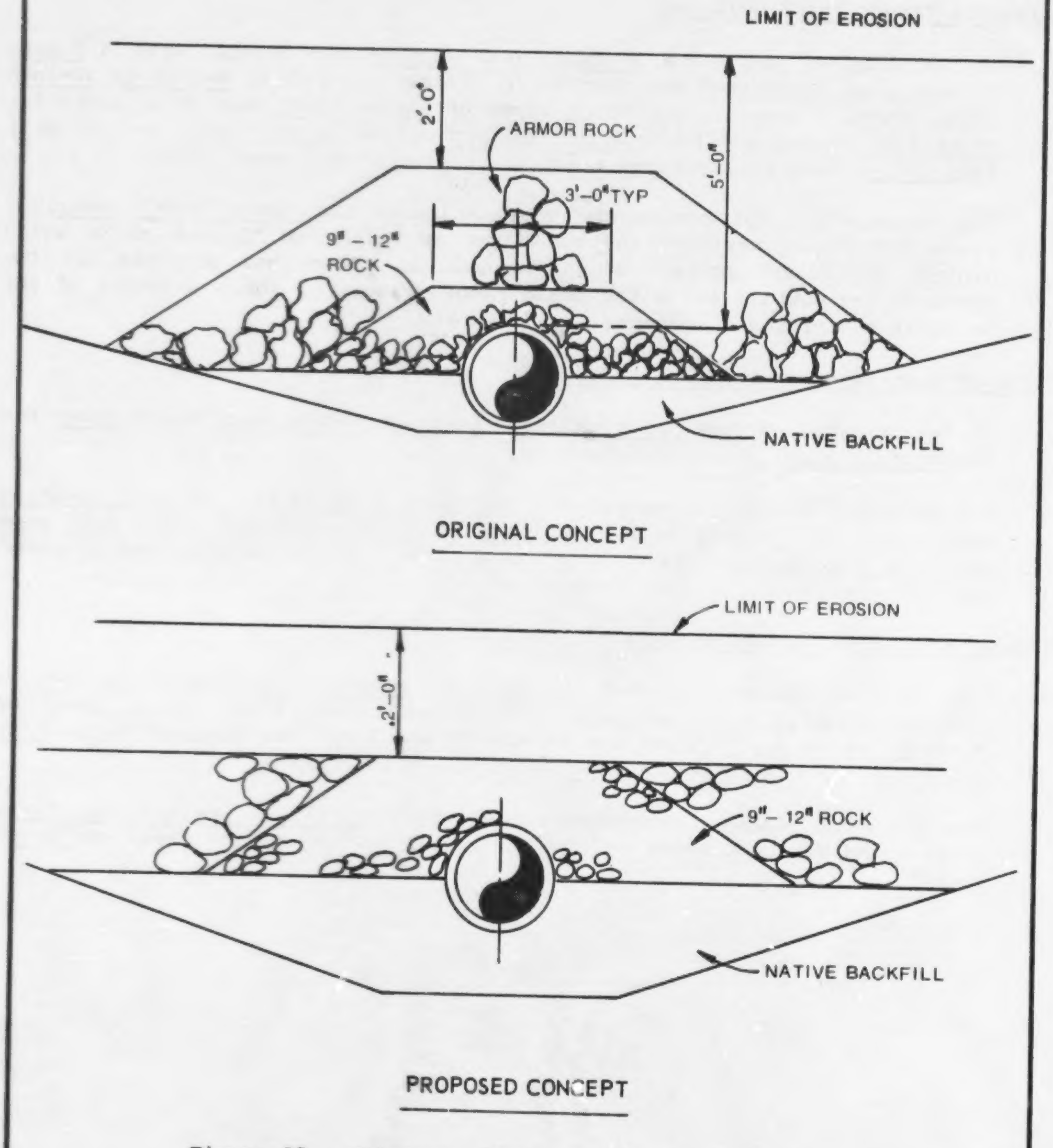
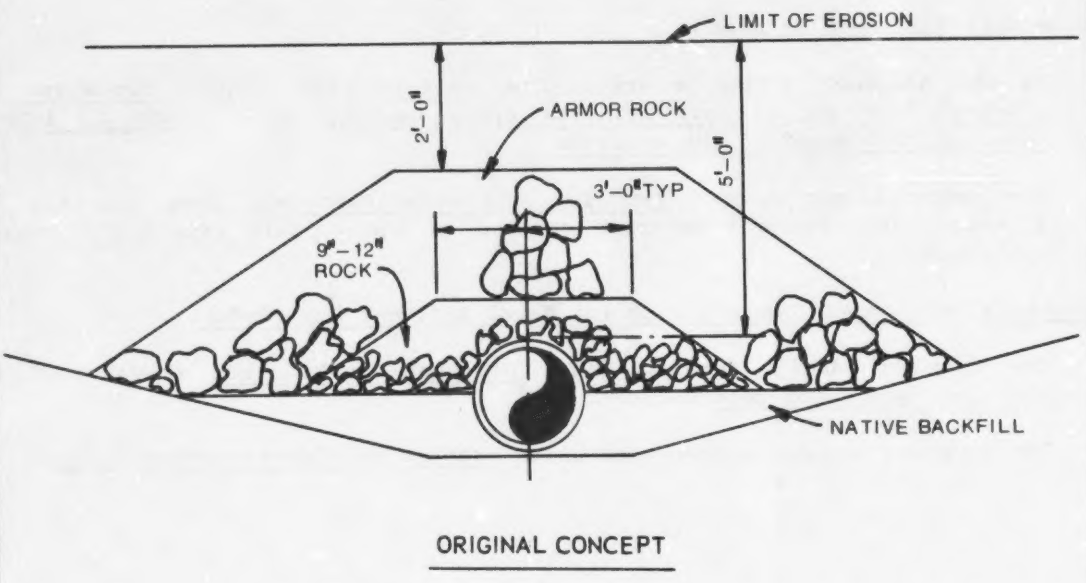

LIMIT OF EROSION
2'-0"
5'-0"
ARMOR ROCK
3'-0" TYP
9" – 12" ROCK
NATIVE BACKFILL
ORIGINAL CONCEPT
LIMIT OF EROSION
2'-0"
9"– 12" ROCK
NATIVE BACKFILL
PROPOSED CONCEPT

Figure 57. Eliminate "Armor Rock" covering.


LIMIT OF EROSION
2'–0"
ARMOR ROCK
5'–0"
3'–0" TYP
9"–12"
ROCK
NATIVE BACKFILL
ORIGINAL CONCEPT

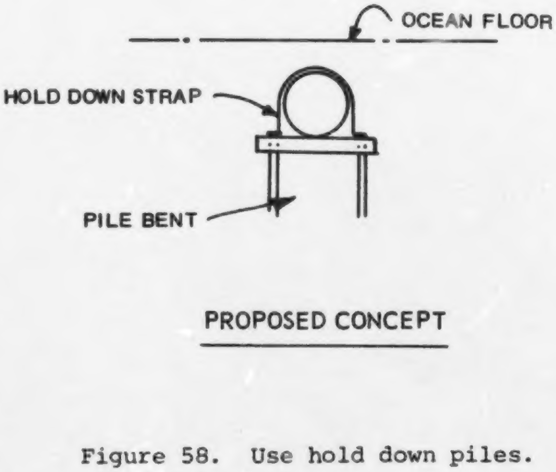

OCEAN FLOOR
HOLD DOWN STRAP
PILE BENT
PROPOSED CONCEPT

Figure 58. Use hold down piles.

CONSTRUCTION MATERIAL

Change From Steel to PCCP

The original outfall design used a steel pipe with epoxy phenolic coating on the interior and coal tar epoxy plus two inches of mortar coating on the exterior.

The proposed concept recommended constructing the pipe of PCCP, with 6 1/2-inch nonfloat concrete covering on the outside.

Reduce Wall Thickness of Pipe

In the original design a steel pipe outfall with a wall thickness of 5/8-inch had an internal coal tar epoxy coating and a 3-inch to 5-inch layer of "Hevicote" on the exterior.

The proposal recommended reducing the wall thickness from 5/8-inch to 1/2-inch. Interior and exterior coating on the outfall pipe would remain unchanged.

Substitute Reinforced Concrete Pipe for Final Effluent Box Conduit

The original design used a final effluent conduit box constructed of poured-in-place concrete.

The proposed concept recommended using precast reinforced concrete pipe.

CONSTRUCTION TECHNIQUE

Reduce Radiographic Inspection

The original design used welded steel pipe with full circumference radiologic inspection of the welded joints in accordance with the American Petroleum Institute (API) Specifications.

Because the outfall would be operating at low pressure, it was suggested that AWWA Spec. C200 for pressure testing be used instead of radiologic testing. However, radiologic testing was recommended on 10% of the joints for verification purposes.

Join Pipe Above Water

The original design used 16 ft lengths of reinforced concrete pipe with individual pipe lengths joined beneath the water surface.

In order to reduce construction and underwater time, the proposed concept recommended joining two or more lengths of the pipe prior to placement in the water for final positioning.

DESIGN CONCEPT

Eliminate Transition Structure

At the transition point between the rigid land section and the semi-rigid ocean section of an outfall, a transition structure was provided. This structure housed valves for insertion of the cleaning pig into the ocean section of the outfall.

It was proposed to delete the transition structure and replace it with solid piping and a flexible connection. The pig insertion location would be at the treatment plant site. This location would allow cleaning of both the land and ocean sections of the outfall.

Eliminate Diffuser

An outfall into a large river had a 200 foot diffuser for dispersion of the effluent. No regulatory agency requirement, direct or indirect, was evident for the diffuser.

The proposed concept suggested that the diffuser be eliminated.

APPENDIX A

VALUE ENGINEERING PROGRAM EVALUATION

The EPA's mandatory value engineering program has been in effect since 1977, with a voluntary program in force for the previous year (1976). Value engineering studies completed under the mandatory program, comprising 93 individual workshop reports, were used to evaluate the effectiveness of the program. The evaluation encompasses subjective and objective conclusions due to the nature of the data. Subjective evaluations present conclusions based on opinions expressed by the EPA's Regional VE Coordinators and discussions with VE consultants. Objective evaluations were based on the data abstracted from the 93 reports.

The VE evaluation is presented under the following general categories:

- Productivity of VE Teams
- Potential VE Savings
- Acceptance of VE Recommendations
- Identification of High Cost Components
- Composition of VE Teams
- Costs and Level of Effort for VE Studies
- Reasons for Rejection of VE Recommendations
- General Observations

In addition, a comparison of the effectiveness between VE teams different from the Design firm and VE teams selected from the Design firm was made, and is included in the following discussions.

PRODUCTIVITY OF VE TEAMS

One measure of the VE teams' productivity is the average number of ideas evaluated by each team member. This is the only item for which data can be directly abstracted from the VE reports. The resulting values are shown in Table A-1.

TABLE A-1. IDEAS EVALUATED PER TEAM MEMBER

	Ideas evaluated per team member		
Value	Overall	Separate VE firm	Same VE firm
Average,	2.82	3.32	1.89
Standard deviation	1.88	1.96	1.13

Inspection of Table A-1 shows that separate VE firms evaluate about 76 percent more ideas than VE teams from the same firm as the designer.

The significance of this fact is clouded by many issues such as:

- Complexity of design project
- Competance and experience of design firm

- Exposure of VE team members to design from different firms
- Experience of team members in participating in workshops

The complexity of the design project influences the time required to consider and evaluate various ideas. If the design is complex, it takes longer to seek out and identify the design alternatives.

The second issue interrelates with the presentation of the design. Firms with greater experience generally think through the design thoroughly, by drawing on past experiences, and thereby minimize the number of alternative designs. More experienced firms avoid obvious design deficiencies, which are frequently introduced by less experienced firms.

The third issue also involves experience, but this time it relates to the VE team member. Team members who have had extensive exposure to designs by different firms can identify alternatives quickly and competently. Exposure could be obtained through plan reviews or by visiting operating treatment facilities and observing the good and bad features at each location.

The final issue deals with the number of workshops completed by individual team members. There tends to be a learning curve effect in VE workshops that indicates improved proficiency in identifying and evaluating alternative ideas with each successive workshop. In other words, the efficiency of individual team members increases with the number of workshops completed.

However, these issues are more applicable to individual projects and not the whole program. Therefore, although the constraints presented must be considered, there is a definite trend that shows VE teams from a different firm are more productive than VE teams from the design firm. Many subjective reasons can be developed around this phenomenon, such as: the VE teams from different firms have to prove their capability; or the VE team may want to show up the design firm because of past grievances; or the VE teams from the design firm have similar design philosophies and therefore do not recognize potential alternative ideas to achieve equal functions; or VE teams from the design firms do not want to create problems for their firm and peer engineers and therefore are not as thorough in their reviewing of the project. Any one or more of these opinions could apply to several of the VE studies, but it is improbable that these or similar reasons would permeate the whole program. Therefore, it appears that a VE study by a firm different from the designer is more productive.

POTENTIAL VE SAVINGS

The potential VE savings have been computed as a percentage of the construction costs to eliminate the effect of project size. These data were developed for various points in the design schedule represented by the percent design completion stage. To identify the potential savings attainable at various points through the design, the same ranges in percent of design completion presented in Table A-2 were used. The results are shown in graphical form in Figure A-1.

Inspection of Figure A-1 clearly shows a point of diminishing return, in terms of the potential savings, the closer the design is to completion. The shape of this curve is consistent with the classic curve published in texts on value engineering which depict a lower potential savings with time.

The potential savings have been subdivided into those developed by VE teams from firms other than the Designer's firm and those VE teams selected from the design firm. The results are shown in Figure A-2. As would be expected from Table 5 on productivity, the VE teams from the Design firm identify a smaller potential savings than those VE teams from different firms. Probably, many of the issues suggested for lower productivity of the VE team from the design firm are applicable to this situation also. The most probable reason is that the team members from the Design firm are entrenched, even subconciously, in the standard design methods used by their firm and therefore do not see alternatives that are obvious to others from outside the firm. They tend to be less "creative" in terms of different design approaches.

Another method of identifying the effectiveness of the VE teams in developing potential savings is to compute the savings per team member. For the VE studies that included more than one workshop, the potential savings from each of the workshops were summed and divided by the total number of team members from all the workshops. The results of this analysis are shown in Table A-2. The overall average potential savings per team member is $353,100. Separate VE team members have a higher average potential savings than some VE teams.

TABLE A-2. POTENTIAL VE SAVINGS PER TEAM MEMBER

Value	Overall	Separate VE firm	Same VE firm
Average	$353,100	$374,200	$238,400
Standard deviation	$292,000	$310,500	$110,800

The potential savings are presented in terms of life cycle costs, which includes an allowance for operation and maintenance (O&M) costs. However, as described in more detail in a later section, very few of the VE reports include O&M costs, and therefore the savings presented represent principally initial capital savings. Less than 15 percent of the reports include O&M costs of any magnitude.

A further analysis was performed to identify the potential saving in terms of dollars ($) per idea by comparing these unit values for potential savings, an indication of the magnitude of the individual ideas. The results of this analysis are shown in Table A-3. The 12 percent difference in the values between the same and separate VE teams is not considered significant when considered in conjunction with the methods of costing of the various ideas recommendation. The "mix" of ideas, that is the ratio of large value ideas to small value ideas is not known, and therefore further deduction cannot be made using this data.

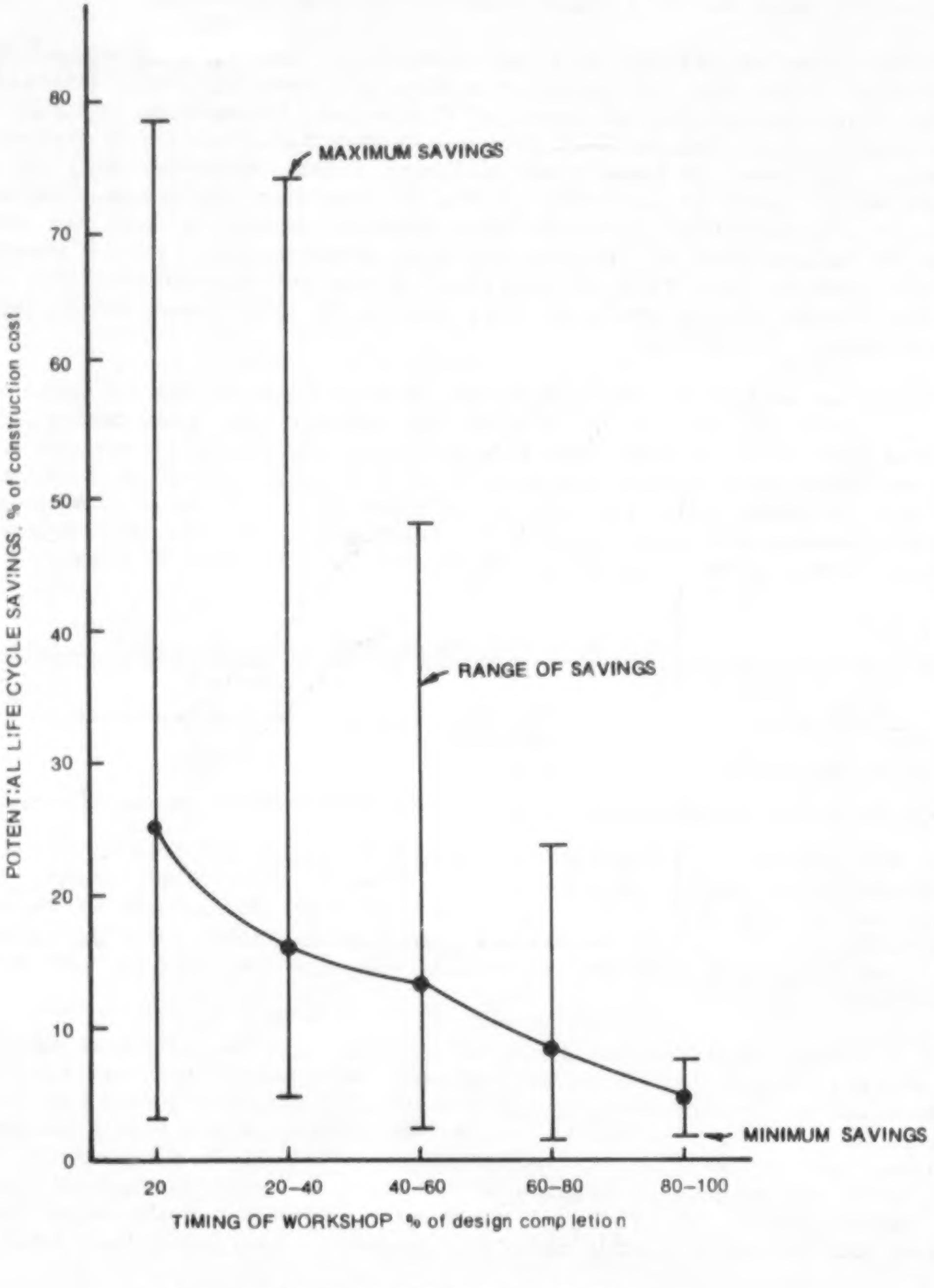


Figure A-1. Potential VE savings.

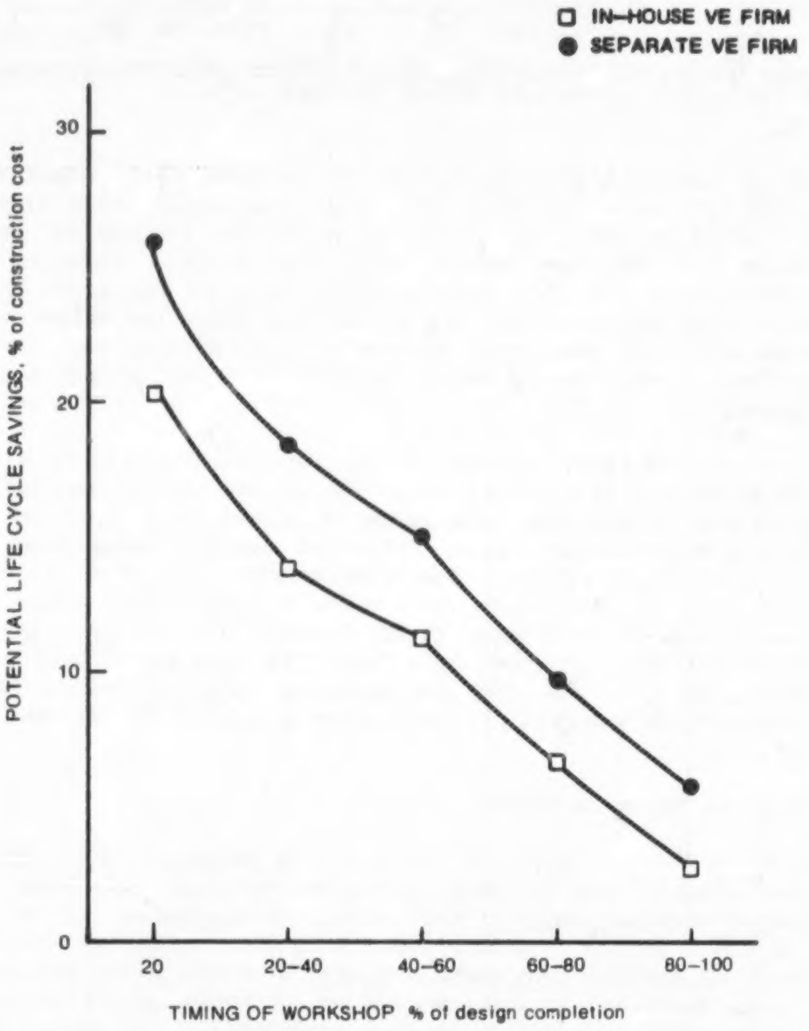


Figure A-2.· Potential VE savings.

TABLE A-3. POTENTIAL SAVING PER IDEA

	Potential Per Idea		
Item	Overall	Separate VE firm	Same VE team
Average[1]	$125,200	$112,700	$126,100

[1] Values in Table A-2 divided by values in Table A-1.

To obtain yet another perspective on the amount of potential savings that could be anticipated, a dimensionless graph showing a trend line was prepared. Using the historical data, the ratio of potential savings to construction cost was plotted against the construction cost. This curve is shown in Figure A-3, and clusters the data points in a more orderly fashion. The trend line was located using professional judgment, and can be used to judge the effectiveness of the VE study. VE studies with identified potential savings that fall on the trend line may be represented as average, below the line is below average and above the line above average.

To show the "shotgun" scatter of the data points, Figure A-4 was prepared. This figure plots the data points of potential savings against construction cost. It is interesting to note the wide range of potential savings in the $10 million to $20 million construction range. Potential savings range from a low close to zero up to about $4.5 million! Possible reasons for this are too numerous to list, and can only be deduced by subjective analysis. They would probably center around combinations of "bad" and "good" designs. For example, the high potential savings could have been produced by a "good" VE team and a "bad" design, with the reverse being the case for the low potential savings point. "Good" and "bad" could be represented generally by experience for both the VE team members and the design firm.

ACCEPTANCE OF VE RECOMMENDATIONS

The most important aspect of the EPA's VE program and the VE studies is the rate of acceptance of the VE ideas or recommendations. Data were abstracted from the individual workshop reports that contained estimates for both the potential savings and the accepted savings. These data were converted into percentages of their respective construction costs and then arranged under the percent of design completion, as described in the sub-section on Potential VE Savings. This analysis was completed for the dollar amounts accepted and the number of ideas/ recommendations accepted. The results are presented graphically in Figure A-5. The curves in Figure A-5 are in general agreement by showing a greater rate of acceptance early in the design, and then again later in the design. The lowest acceptance rate is found at about the mid-point of the design schedule. The average acceptance rate for the dollar values is about 46 percent while that for the ideas/recommendations is about 44 percent. The evaluation of this category for the VE teams from separate firms and those from the same firm resulted in an interesting reversal as was shown in Table A-4. The VE teams from the design firm have achieved a better acceptance rate than those from separate firms. There are several reasons that could explain this fact. These include:

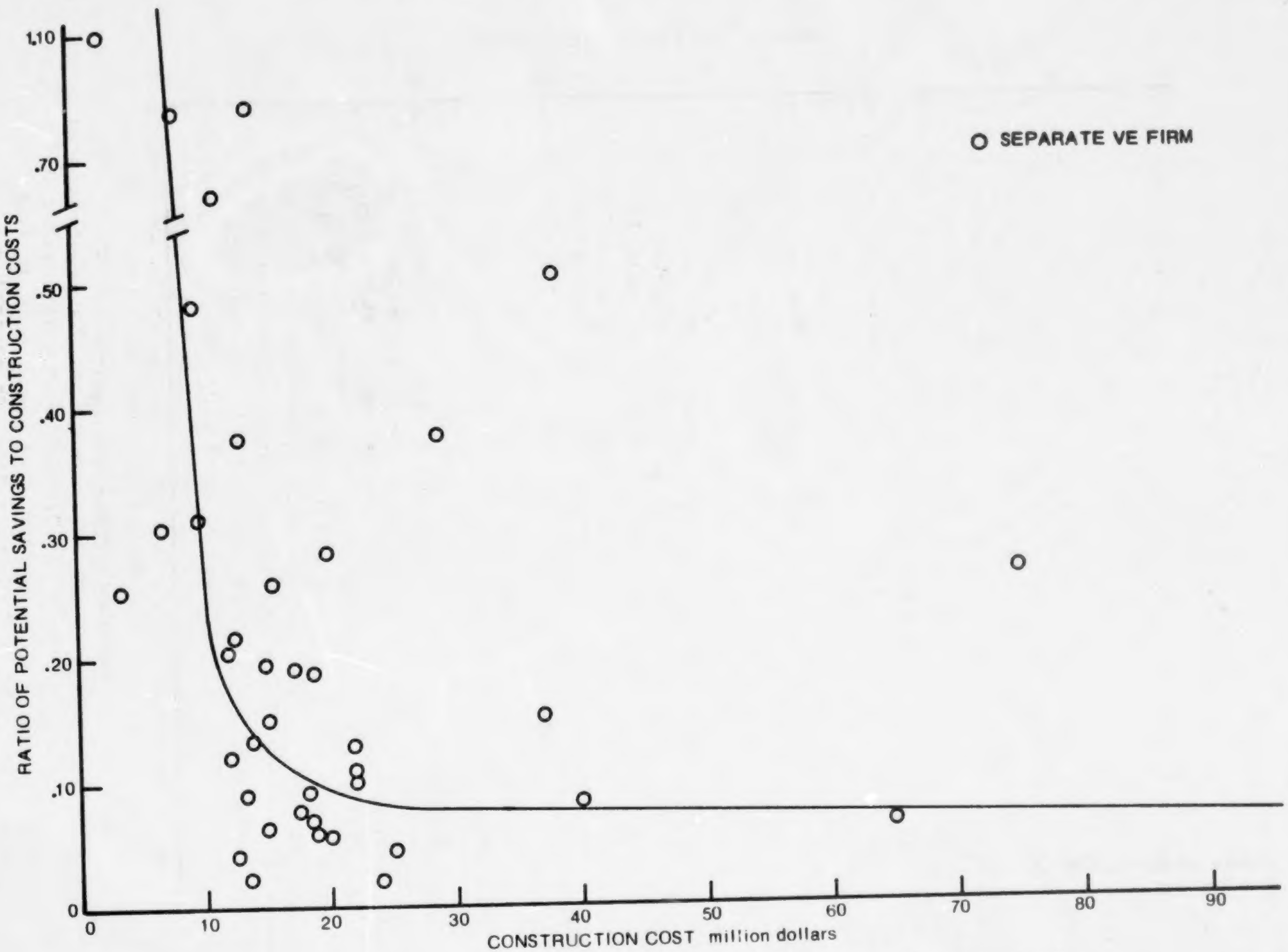


Figure A-3. Estimation of potential savings from VE Study.

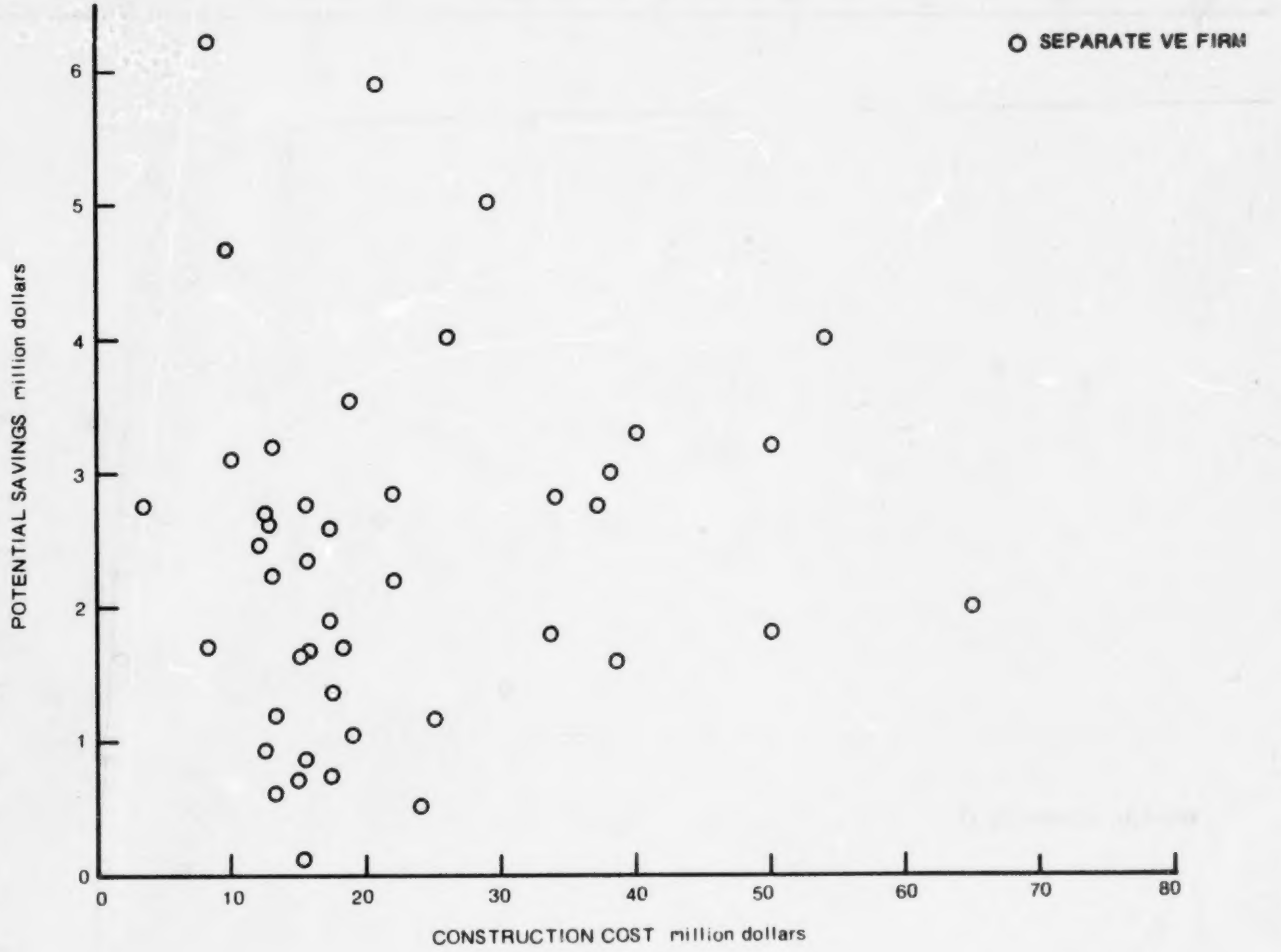


Figure A-4. Variability in potential VE savings.

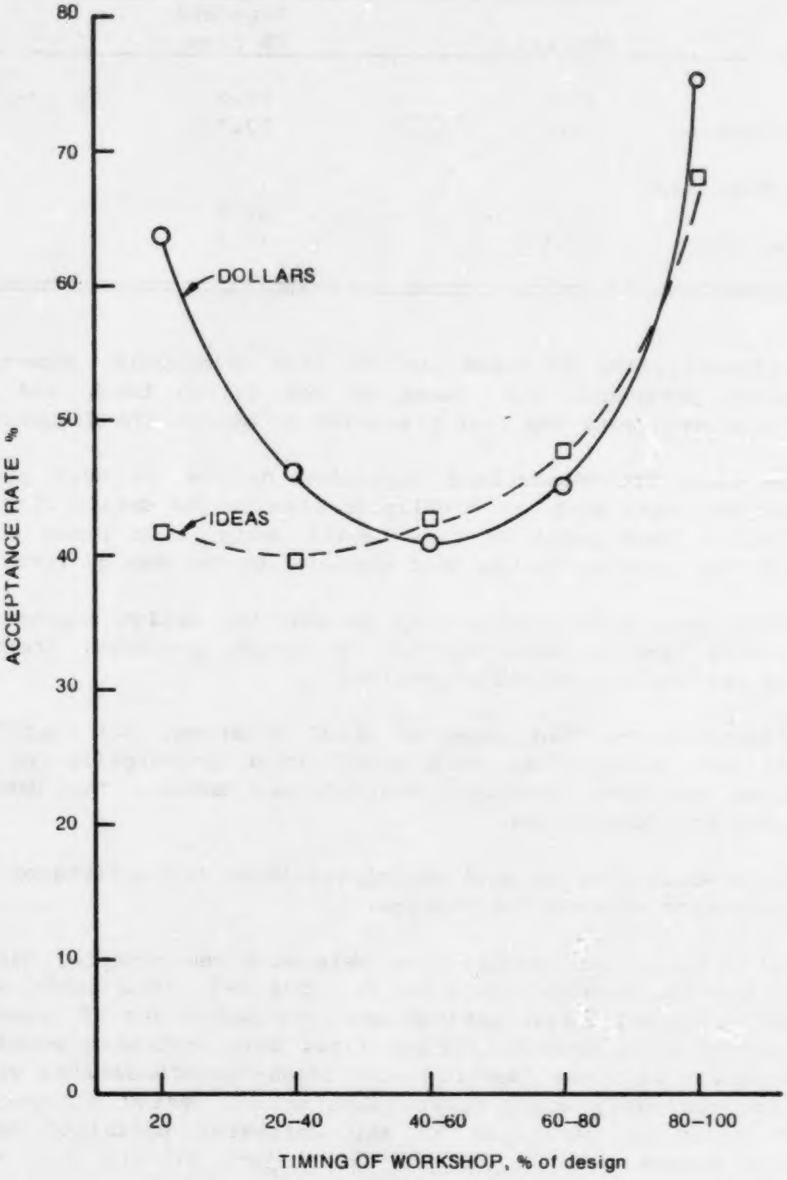


Figure A-5. Acceptance rate of VE ideas.

TABLE A-4. ACCEPTANCE RATE OF IDEAS/RECOMMENDATIONS

Item	Acceptance Rate, percent		
	Overall	Separate VE firm	Same VE team
DOLLAR			
Average	45.6	39.2	52.5
Standard Deviation	25.4	23.7	24.8
IDEAS/RECOMMENDATIONS			
Average	43.9	39.9	50.8
Standard Deviation	20.1	18.5	21.3

- Frequently, the VE teams include firm principals, supervisors or more senior personnel than those on the design team, and therefore the design engineers may feel pressured to accept the suggested ideas.

- The ideas/recommendations suggested by the VE team probably do not include ideas that are totally foreign to the design firm. (They do not offer a fresh point of view to the design). In other words, they fit into the general design mold expoused by the design firm.

- Peer pressure may play a role in that the design engineers and VE team members have to work together on future projects. Greater acceptance may relieve any possible tensions.

- Eliminates the "not invented here" syndrome, and therefore the ideas are more acceptable. This would occur principally in long standing firms who have developed standardized methods for designing certain items and facilities.

- There would also be less skepticism about the motives of the VE team in suggesting alternative designs.

A second analysis was completed to determine the accepted dollar saving per team member, and the results are shown in Table A-5. This table shows a significantly higher accepted dollar savings per team member for VE teams from separate firms than for VE teams from the design firm. This statistic would tend to indicate that separate VE teams identify more ideas/recommendations with significant savings, which obviously would create substantial design changes. These higher values also could be reflected in the estimated operation and maintenance savings, which extend over the life of the project and are born entirely by the local community.

To deduce the magnitude of the ideas accepted, the ideas accepted per team member were computed, and in conjunction with Table A-2, the dollars per idea were obtained, as shown in Table A-6. Inspection of this table shows that the dollars per idea accepted for separate VE teams is about 111 percent greater than for the VE teams from the design firm, which is a significant amount. It tends to

TABLE A-5. DOLLAR ACCEPTANCE PER TEAM MEMBER

Item	Acceptance per team member, $1,000's Overall	 Separate VE firm	 Same VE firm
Average	129.8	145.7	82.1
Standard deviation	99.8	103.9	71.8

TABLE A-6. DOLLAR ACCEPTANCE PER IDEA

Item	Acceptance rate Overall	 Separate VE firm	 Same VE firm
IDEAS PER TEAM MEMBER			
Average	0.45	0.42	0.50
Standard deviation	0.21	0.20	0.22
DOLLARS PER IDEA			
Average	288,400	346,000	164,200

ideas for VE teams from the design firm than for separate VE teams. VE teams from the design firm show a higher acceptance of smaller ideas, which together total to a higher value than for separate teams. However, this fact also indicates that there are fewer radical or different design approaches, which might be considered less creative or imaginative by some people.

Finally, to test whether the rate of acceptance was affected by the report presentation and organization, each of the workshop reports were subjectively rated. The rating was based on the ease with which data could be abstracted, report organization, inclusion of unnecessary extraneous material, conformance with the EPA format, thoroughness of data evaluation and the overall appearance. Naturally considerable personal preferances are included in the ratings, but they do tend to identify trends. The ratings were divided into three categories: below average, average, and above average. The major determining factor was conciseness and clarity of the reports. The results are plotted graphically on Figure A-6 and show a distinct improvement in the rate of acceptance with an improved report.

IDENTIFICATION OF HIGH COST COMPONENTS

To obtain an indication of the high cost components of wastewater treatment facilities, the bid tabulations of several treatment plants were studied, and the costs were divided into the standard 16 division format recommended by the Construction Specifications Institute (CSI). Using these costs, their percentage of the total cost was determined and is presented in Table A-7.

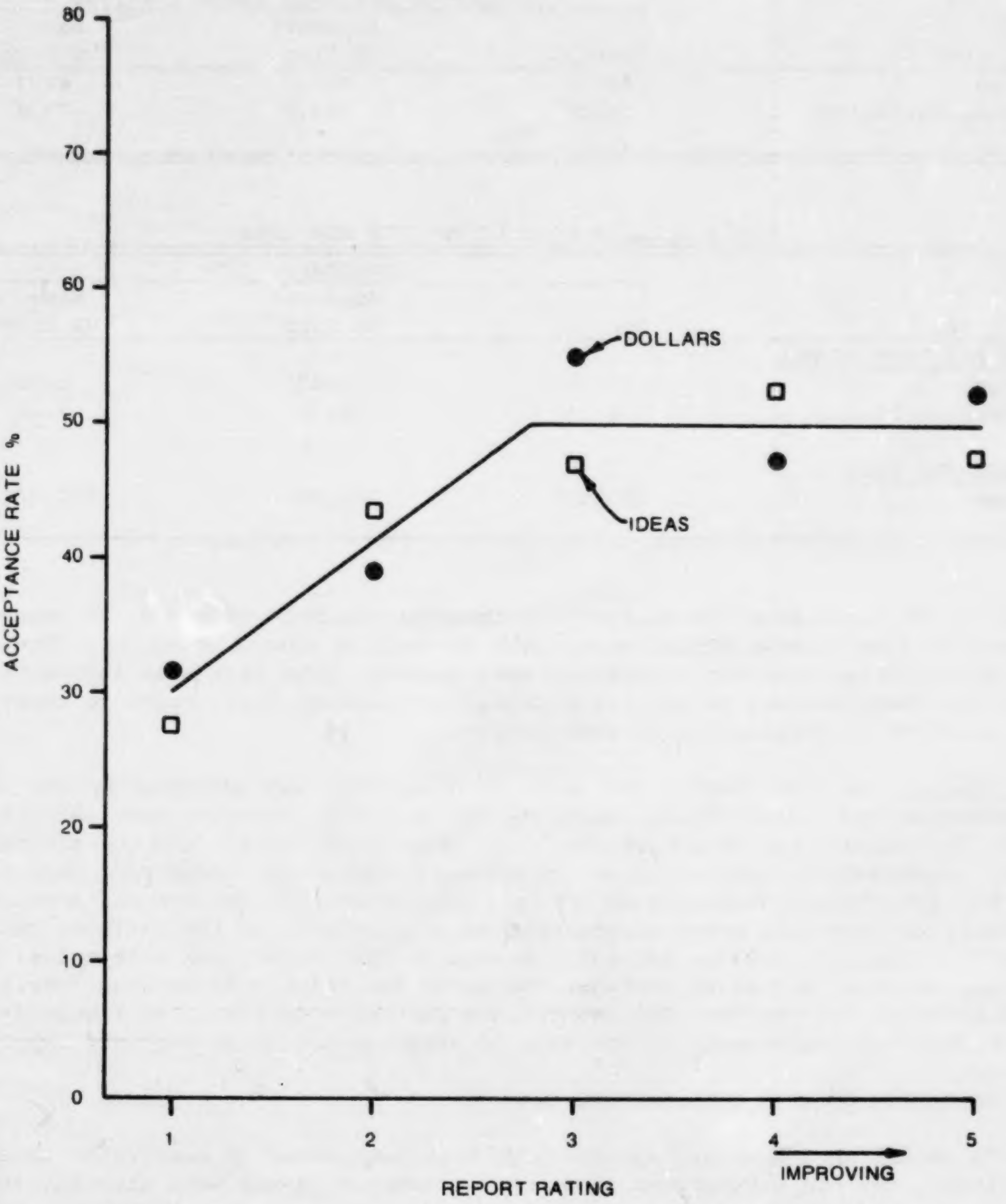


Figure A-6. Acceptance rate based on report presentation and organization.

Inspection of Table A-7 shows the major costs for a wastewater facility are in concrete, equipment and mechanical divisions, each representing about 20 percent of project costs. The next tier of costs are included in the site work, metals, special construction and electrical divisions, representing between 5 and 11 percent of the project cost. The remaining nine divisions combined make up only 9.6 percent of the total construction costs. However, although these nine divisions make up a small percentage of the total constructions cost, individually, they could represent a significant savings to the project.

TABLE A-7. IDENTIFICATION OF COSTS

CSI division no.	Division title	Percent of total construction costs: Average	Percent of total construction costs: Range
1	Concrete	21.4	12.7 - 35.0
2	Equipment	21.3	12.5 - 20.4
3	Mechanical	17.1	10.0 - 30.5
4	Sitework	11.0	6.0 - 21.7
5	Electrical	9.3	5.0 - 18.0
6	Metals	5.4	2.6 - 10.0
7	Special construction	4.9	2.3 - 7.4
8	General requirements	2.6	1.6 - 4.0
9	Finishes	1.5	0.8 - 1.6
10	Masonry	1.5	0.0 - 2.9
11	Wood and plastics	0.9	0.1 - 3.8
12	Thermal and moisture protection	0.9	0.4 - 1.5
13	Doors and windows	0.6	0.3 - 0.9
14	Specialties	0.5	0.0 - 1.0
15	Furnishing	0.7	0.0 - 1.7
16	Conveying systems	0.4	0.0 - 1.4

The treatment facilities used to determine the cost identification in Table A-7 represents a cross-section of geographical location, type of facility and design engineer. The facilities vary in size and complexity and therefore are fairly representative of the treatment plants being constructed in the U.S.

COMPOSITION OF VE TEAMS

The data presented in Table A-7 reflect the disciplines necessary for the VE teams. Care should be exercised in selecting team members to ensure an adequate level of experience in the engineering disciplines necessary for a particular workshop. The design of wastewater treatment facilities, especially smaller facilities, is largely coordinated and completed by sanitary engineers. Inspection of Table A-7 shows that sanitary engineers have principal control of over 70 percent of the construction cost of a project. The sanitary engineer normally selects and sizes all tankage and basins, specifies the equipment and completes a majority of the mechanical work. Obviously other engineering disciplines are a part of any design team, but, with the exception of electrical engineering, they only affect about 20 percent of the construction cost of the project.

These facts should be carefully considered when assembling a VE team. Also, the timing of the workshops is another important variable to consider when establishing a VE team. As the design nears completion, the team members selected should have experience in design aspects.

All VE teams should include a minimum of two sanitary engineers in order that they can inter-react and thereby gain the most benefit in the creative phase. Early in the design phase, architectural, mechanical and structural engineers are not really needed as the design is ill-defined in these disciplines. Depending on specific circumstances, a geotechnical engineer may be desirable. Later in the design, when working drawings are available, the other disciplines should be included if the type of facility warrants it. An architect may be desirable for most VE studies because of their knowledge of building materials which is applicable to more than the site buildings. Architects may affect as much as 10 percent of the construction cost by accumulating the areas in which they are directly involved.

In summary, the VE team composition should be assembled after carefully considering the following:

- High cost components - favor more sanitary engineers
- Timing of workshop
- Special construction consideration or techniques
- Type of facilities to be constructed

After evaluating these factors, the VE team can be selected.

COSTS AND LEVEL OF EFFORT FOR VE STUDIES

The engineering costs of the completed VE studies were analyzed and the data plotted in Figure A-7. The line of best fit, using a least squares analysis, was also computed and is indicated on the drawing. Naturally there will be differences in VE costs, principally associated with expenses and the overhead rates of the firms, but this curve represents historical fees for a project.

The level of effort required for VE studies was also evaluated from other data abstracted from the individual workshop reports. The total number of team members (number of workshops times number of team members in each workshop) for each VE study was plotted against the estimated construction costs, as shown in Figure A-8. Superimposed on this figure is an envelope of the suggested level of effort necessary for conducting a VE study. The upper and lower limits were established by considering the data, experience in conducting VE studies and discussions with consultants who perform VE studies. The envelope represents only a guideline for establishing a reasonable number of team members for the study and is based on a minimum of one workshop.

To test whether there is any correlation between the number of team members and the potential savings, a second plot of data points was completed, as shown in Figure A-9. Inspection of this figure shows that there does not appear to be any advantage to have more than 11 team members, at least for the smaller projects.

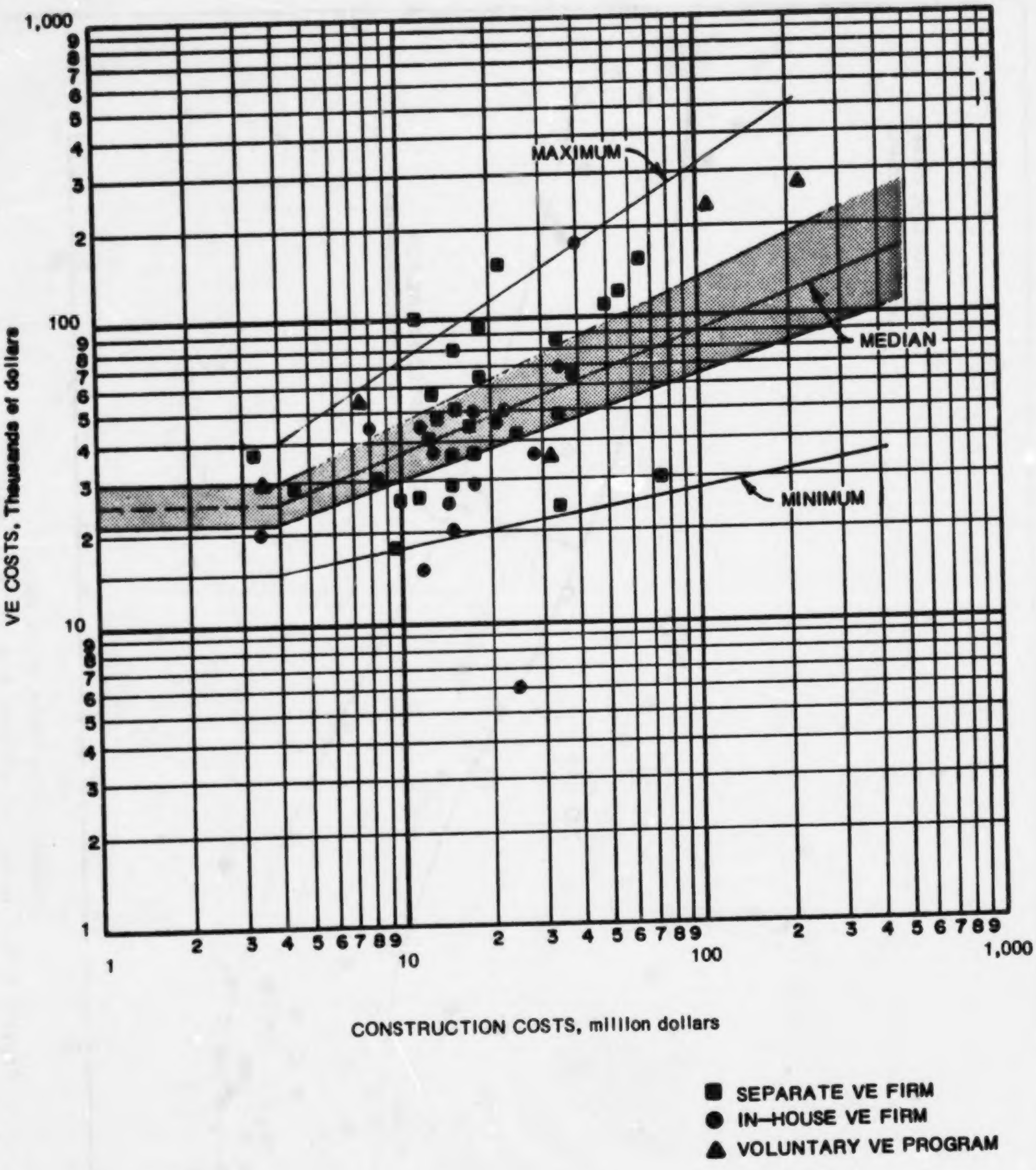


Figure A-7. VE fees.

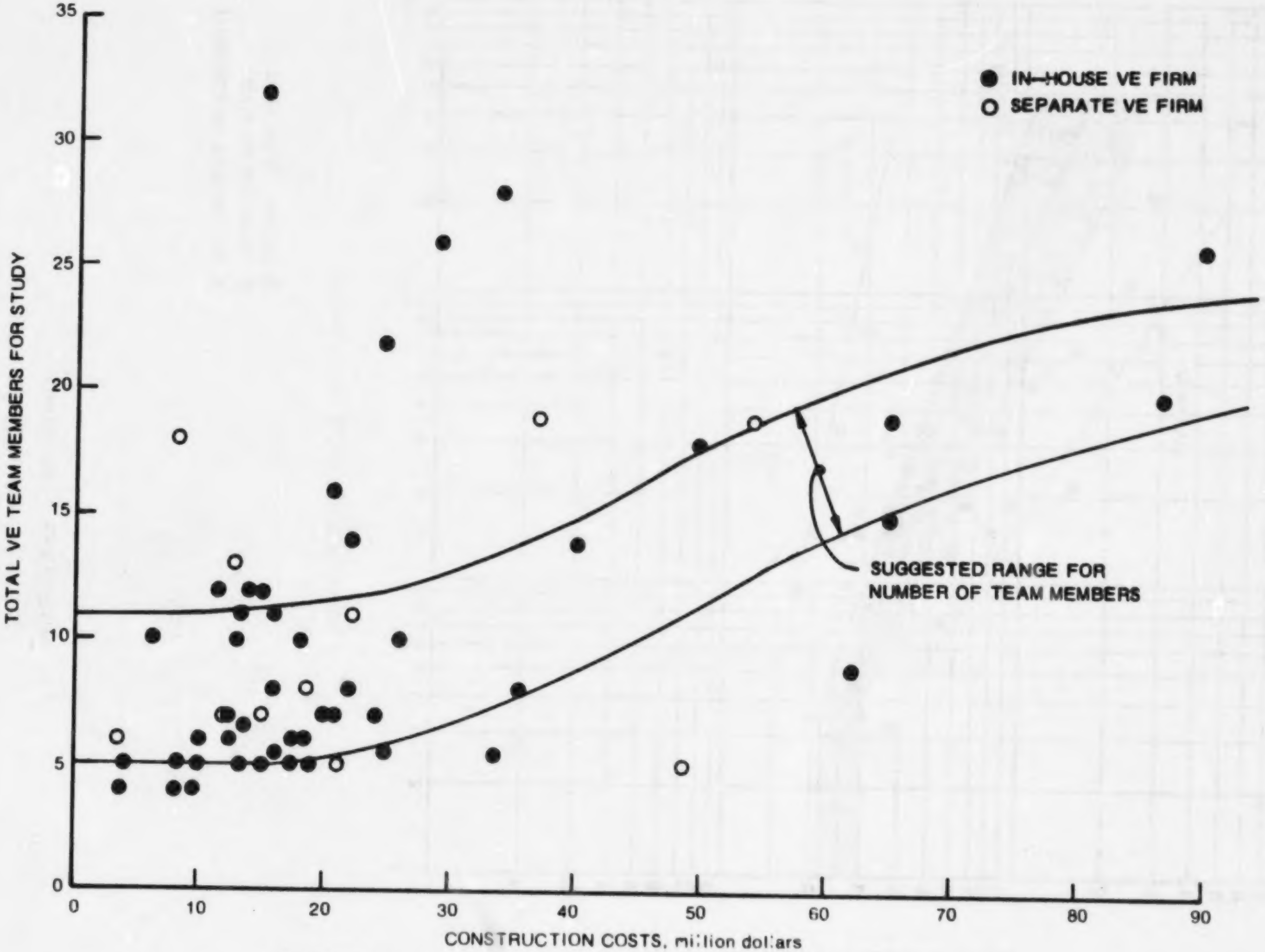


Figure A-8. Level of effort for VE studies.

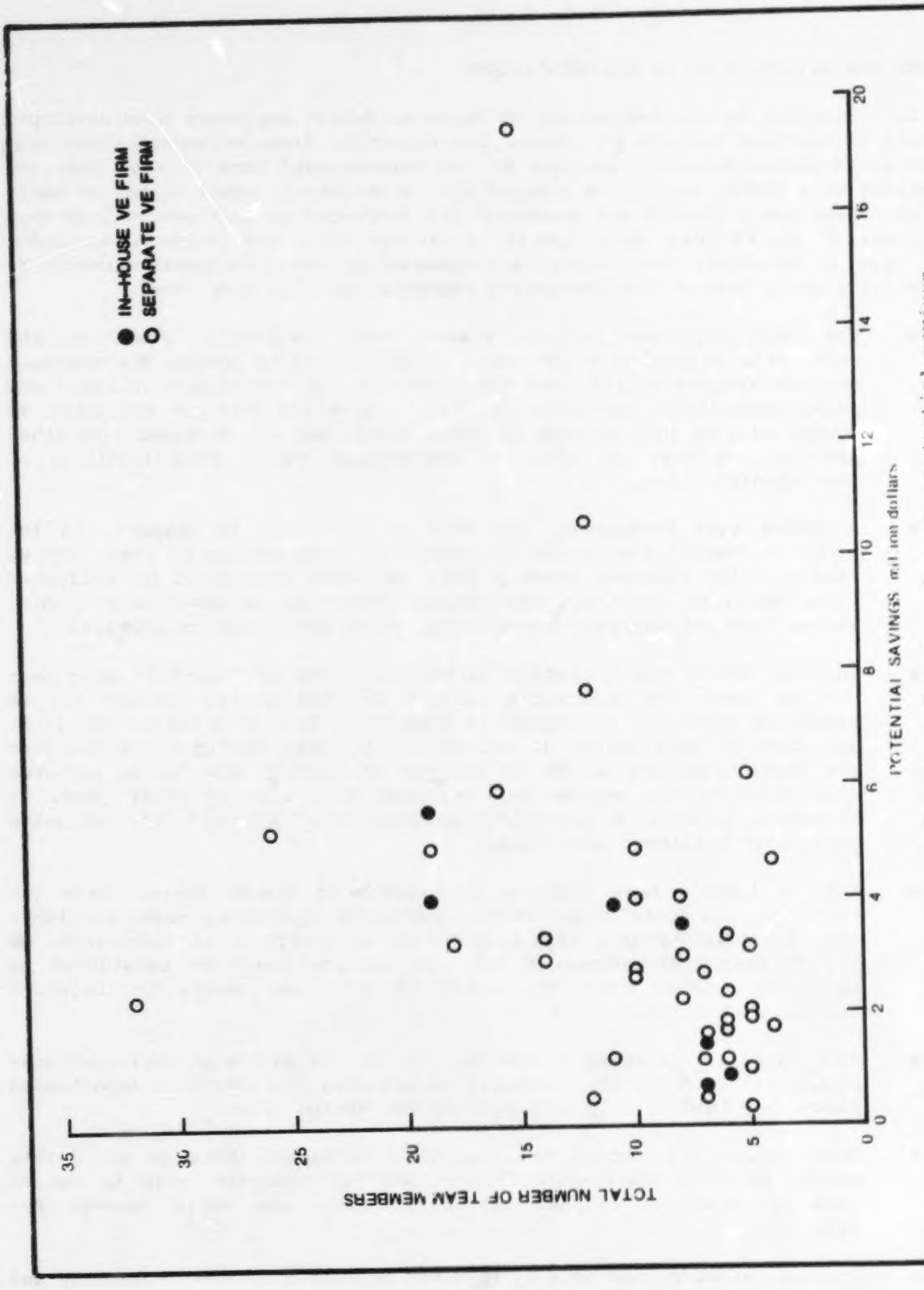


Figure A-9. Total number of team members vs. potential savings.

REASONS FOR REJECTION OF VE RECOMMENDATIONS

In responding to the Preliminary VE Reports, Design engineers have developed and used an enormous variety of reasons for rejecting ideas/recommendations suggested by VE teams. However, analysis of the reasons used tend to show they are variations of a theme, and can be grouped into a relatively small number of basic reasons. These basic reasons are presented and discussed in this section. In many instances, if the VE team could specify locations where the process, equipment item, type of material, etc. which is suggested in the idea/recommendation is successfully used, many of the Designer's concerns would be alleviated.

- The most important single reason that frequently underlies the Designer's rejection of an idea, is the liability issue. The Designer has the responsibility, and the liability, of ensuring a reliable and fully operational treatment facility. If a Designer is obligated to accept an idea that he does not understand, has not designed into other projects, or does not like, he may request relief from liability on that specific item.

- A reason used frequently, and that is difficult to dispute, is the probable "delay" that would be caused by implementing an idea. The VE team normally includes redesign fees and makes allowances for estimated times based on their own experiences. These may be substantially different from the Designer's estimates, which would have to prevail.

- The most often used rejection is basically one of "opinion" on a particular item. The Designer's opinion is then pitted against the VE team's opinion, and the client is frequently left with making the final decision. In many cases, it represents an "easy out" for the Designer who doesn't believe in the VE program or doesn't want to be bothered with changing the way he has designed this item on other jobs. It therefore harbors a generally unimaginative approach to designing wastewater treatment facilities.

- Many Designer's have used safety aspects to reject ideas. These can extend to all areas of the design including equipment, roads and tankage. Using safety as a rejection reason is difficult to counteract, as any VE team that voices an opposing opinion could be considered as being unconcerned about the safety of plant personnel. It therefore becomes an emotional issue.

- Many ideas are rejected by the Designer on the advice of equipment suppliers and vendors. This normally occurs with smaller, less experienced firms that tend to rely on suppliers for design help.

- Geotechnical information has been used to reject ideas as well. This occurs when the geotechnical report was not made available to the VE team for whatever reason. Typically, these are valid reasons for rejection.

- In some cases, a good idea is rejected because it is new technology and the designer did not want to take a chance on failure. However, with the new Innovative/Alternative program introduced by the EPA recently, these may not occur as frequently.

- A rejection that has been used occasionally is an admission by the Designer that he did not provide adequate background material. The suggested recommendation is good, but because of these other considerations, of which the VE team was not aware, it cannot be implemented, and must be rejected. The VE Team Coordinator (VETC) therefore should ensure that all available and pertinent information is collected for the workshop. The presence of an Owner's representative at the workshop is another method that can be used successfully to stem this type of rejection.

- Another type of "rejection" is based on previous implementation of the idea. The Designer's response is typically, "That's a good idea which we have already incorporated into the design. Unfortunately, the drawings showing this change were not available for the VE workshop". This rejection really is an acceptance of the idea, which is the intent of the program, but a rejection of the VE team's recommendation.

- One rejection used infrequently was based on the fact that a regulatory agency required that the original item be incorporated into the design. In this case, the specific item should have been listed as a constraint, and not allow the VE team to waste valuable time evaluating alternatives for this item.

- On several occasions an idea initially has been accepted by the Designer, only to be rejected later. Later rejection is usually based on a more detailed re-evaluation of the idea and its affect on other facilities in the plant. Rejection could be based on cost or other features such as incompatibility with selected equipment etc. This type of rejection is unavoidable, because it is based on a more careful evaluation by the Designer, who initially had liked the idea.

- The final rejection listed here is the idea of flexibility, which has already been included under the rejection based on opinion. In this case the idea relates to the "required" amount of flexibility and therefore infers a pre-determined judgement. Typically, it is used in cases such as "Fewer units don't provide the required amount of flexibility". The VE team should be provided with all documentation relative to any specific requirements of the design.

GENERAL OBSERVATIONS

Many observations were noted during the review of the 93 individual workshop reports, and these are presented here in an effort to improve the overall program by identifying pitfalls and successes. Hopefully, if future design engineers and VE team members review and think about these comments, everyone will benefit from performing Value Engineering studies. Many observations are similar to those presented in the EPA manual on Case Studies (EPA-43019-77-009). The following are the general observations.

- The VE program has been eminently successful when measured in terms of estimated life cycle cost savings.

- For the open minded participants in the VE process, the VE workshop has broadened horizons on alternative design techniques. The program actually provides a good mechanism for the exchange of ideas and information regarding wastewater treatment facilities.

- Participation of an owner's representative in VE workshops has proved beneficial to both parties. The VE team gains from the background information provided by the representative while this person gains from the frank discussions about alternative ideas, which therefore give the owner a better understanding of the ultimate facilities.

- Participation in the VE process builds a greater awareness of investigating design alternatives and thinking through the proposed design more thoroughly. Any designer who knows his project is going to be value engineered will tend to be more thorough in the design and officially evaluate all elements of the design before they are submitted to the VE team.

- Increased frequency of participation in VE workshops sharpens skills of the team members. This results in more efficient and productive workshops. Participants know what to expect and are use to the formalities of going through the five VE phases, and are able to recognize high cost areas quickly. New team members tend to feel insecure and some pressure as they don't know what to expect next.

- It is apparent from reviewing the workshop reports and participating in value engineering studies that designers frequently do not understand the alternative. As a result, good ideas are often rejected. It is important to ensure that ideas are well presented and explained. Whenever possible, sketches should be used for each recommendation, along with clear, concise and legible computations and notes showing all assumptions.

- Many preliminary VE reports contain poor backup notes relating to the specific recommendation. The Designer therefore has difficulty in following the recommendation through and rejects the idea. This observation follows from the previous one.

- Many recommendations presented in preliminary VE reports encompass more than one idea. Frequently, the whole recommendation is rejected because of a single bad idea and several good ideas are lost. VE teams should be encouraged to include only a single idea in each recommendation and avoid the concept approach. The latter approach could be incorporated by combining several individual ideas to show an overall suggestion.

- Each recommendation page (worksheet 10 in the VE workbook) should include a concise description of the "before" and "after" concepts of the idea. Including these will demonstrate to the Designer that the VE team has grasped the intent of the original concept. Conversely, if the

VE team is incorrect in their interpretation of the concept, the description presented will clearly identify the error. This requirement will also improve communication with third parties reviewing the reports, such as regulatory agencies, personnel not directly involved in the process (council members), and other staff members from the Designer and VE firms.

- The concept of including only a single idea per recommendation will result in many recommendations that are mutually exclusive. This is not a detraction, but rather it presents an opportunity for the Designer to select an idea from a number of good ideas. It also provides the vehicle to present several alternative methods of accomplishing the same function.

- Discussions with regulatory personnel, VE teams and designers indicates there is some distrust of outside firms doing the VE. This is especially true if the firms are from the same geographic area and compete regularly for projects. This probably will become less significant as time passes, and the VE process is more understood by consulting firms.

- There has been much criticism of the VE program by consultants who feel that their design capability and integrity are being questioned, and that the program is not warranted. Their selection as the Design Engineer by the client indicates they were the most qualified for the project. These people fail to realize that VE is not an imposition or a slur on their ability, but rather VE provides an opportunity to obtain differing viewpoints from other knowledgeable engineers. There is room for improvement on any design or project and VE provides the opportunity to tap these ideas at relatively little cost.

- Most of the savings identified in the VE reports were related to initial costs. The inclusion of operation and maintenance (O&M) requirements was singularly poor. Even though much O&M data is already available in several published and unpublished reports, there should be a single publication containing a comprehensive O&M cost guide on wastewater treatment facilities.

- Many reports reviewed were inconsistent in the method of completing life cycle costs (LCC's), and some did not even include these computations. It is imperative that LLC's be completed as accurately as possible. This suggestion also requires additional cost data as mentioned in the previous observation.

- Many of the reports were very badly organized and contained totally inappropriate information. Review of the Preliminary VE Reports would be easier and quicker if the general EPA format is followed by the VE team. This will ensure uniformity in report content and elimination of unnecessary information. As shown earlier in this chapter, poorly organized and presented reports result in a lower acceptance of VE ideas/recommendations.

- There appears to be a tendency in VE teams to strive toward the "goal" of identifying savings in a ratio of 10 to 1 over the VE fee. Another item is the "bean count" factor which requires that the VE team evaluates at least 3, 4, 5, or more ideas per team member to show they have done their work competently and thoroughly. Frequently, these two factors cause the VE team to lose sight of the purpose of the VE program and in their zeal to achieve their "goal" or "bean count" include ideas that they would not implement themselves. VE team members should be encouraged to consider all ideas carefully and develop the alternative as though they were going to use the idea on one of their own projects. VE teams should also be encouraged to identify those ideas/recommendations that are not as good as the others or would not be "pushed" by the VE team.

- The VE report should include an abbreviated description of the project including background history, and proposed project elements, design criteria and any special items. This description should not exceed two pages, and would provide the reader with an immediate overview of the project.

- There was very little attention paid to energy consumption or energy recovery in most of the VE reports reviewed. VE teams should be urged to take account of energy requirements and identify comparative requirements. Energy recovery systems should also be investigated in more detail to determine their cost-effectiveness in offsetting energy demands.

- The Designer's responses to the VE team's recommendations tended to be long winded and often circumvent the subject. Responses should be concise and as short as possible, commensurate with ensuring that the response is understood. If the idea/recommendation is accepted, simply write "Accept" for this item. Only items that are rejected need an explanation.

- There has been a wide variation of idea acceptance in the VE program. Typically smaller, inexperienced firms reject ideas on the basis of personal preference, less qualified opinions, and recommendations of others. Larger, more experienced firms, tend to reject ideas because they hold their own ability above that of the VE team. They also resist changes to their standard way of design facilities. The VE team must develop clear ideas that are well explained with examples of where and how the ideas are to be implemented.

- VE teams from the Design firm tend to be less critical of designs than VE teams from different firms. There is probably a subconscious effort not to make too many changes that would delay the design completion. Their idea/recommendations tend to be minor in a possible effort to avoid major changes.

- Many firms appear to be completing the VE study simply because of the EPA regulations, and not because of the advantages the program. It is important for the Designer not to be "threatened" with a VE study, but rather be encouraged to utilize the VE study to design a better project.

- There has been much discussion on the amount of information that should be supplied to the VE team. It seems that too much information can and does stifle the creativity of the VE team. The ideal level of information would be that which allows the proper development of ideas/recommendations but does not overwhelm the team.

- The experience of the VE team is one of the most important features of a successful VE study. Experienced participants bring broad and divergent viewpoints to the workshop which results in an ability to effectively identify high cost areas and then cost out the alternatives. It is more important to have experienced engineers on the team than to require that all team members have attended the 40 hour training workshop. Typically, a firm sends the younger less experienced engineers to these schools, but they don't have the necessary experience to maximize the benefits of the study. The VE team coordinator needs the ability to direct the team's conduct, ensure that they keep on track, and maintains a positive, creative attitude at the workshop.

- The VE team members should be carefully selected for each specific project. Workshops conducted with relatively inexperienced people resulted in poor reports. The discipline and experience of team members should be dictated by the timing of the workshop. Early workshops require more process or conceptual oriented participants while later workshops require more design and operation engineers.

- A workshop tends to be less creative when the team includes a large number of members from different firms. Team members tend to be restrained in the presence of engineers from other firms. This is probably due to the unknown ability of other engineers and therefore there is a certain degree of distrust. However, after working together on a couple of projects, these imaginary barriers are removed and the VE team functions efficiently.

- Designers frequently take the ideas/recommendations personally. There is a great deal of "pride of authorship" in the designs and the Designers naturally "defend" and finds excuses for the manner in which they designed the facility or item. As the program becomes more accepted, there should be less of a defensive attitude and more of a cooperative attitude.

- There needs to be a greater participation in the VE process, and especially the workshops, of staffs from regulatory agencies. This participation would demonstrate a commitment to the VE program and provide them with a better understanding of wastewater facilities design. This participation would increase the regulatory agencies effectiveness in reviewing various wastewater projects. The agency representative preferably should not be one of the project reviewers.

- The constraints imposed on a VE team should be listed and explained prior to the start of a workshop. This will increase the quality and acceptability of the teams recommendations.

- Communications between the Designer and the VE team are an important element in the success of a VE study. It is important that the VETC establish positive communication between the Owner, the Designer and the VE teams at the earliest possible date. The VETC should develop a "rapport" with the Designer and avoid an antagonistic approach.

APPENDIX B

IDEAS APPLICABLE TO MOST WASTEWATER TREATMENT PROJECTS

During the review of the 93 VE workshop reports, many of the ideas presented could be called "good design practice". These ideas addressed items that were inadverently overlooked in the formulation of the initial design. These design features are applicable to most wastewater treatment facilities.

The design of wastewater treatment facilities requires anticipating potential problems; having a sensitivity to the site in terms of engineering and environmental issues; recognizing and including the many details for constructability and operability; and coordinating all component parts in order to achieve a cost-effective, easily operable and convenient treatment facility. It is the intent of this chapter to identify and briefly describe some of the items that should be considered during the design phase and in VE workshops. These items may seem obvious to most designers, but they were not included in many of the VE reports reviewed during this study. The items are presented under the following general categories:

- Design Criteria
- Site Work and Layout
- Site Buildings
- Structural
- Equipment
- Mechanical
- Electrical
- Energy conservation
- Miscellaneous

DESIGN CRITERIA

1. Influent Design Data. Ensure that the wastewater treatment plant has been designed for the maximum day influent wasteloads.

2. Design Criteria of Unit Processes. Review the design criteria for each unit process to ensure that it is sized within acceptable limits.

3. Hydraulic Profile. Review the hydraulic profile to determine whether or not any intermediate pumping stations can be eliminated to save energy. Also, ensure that sufficient head exists across the plant to pass the peak hydraulic flows during the 100 year flood condition.

4. Unit Selection. Ensure that a complete economic analysis has been completed before selecting individual unit processes. The economic analysis should include both capital and operation and maintenance costs of the system and an evaluation of the effect the system may have on other processes. For example, the effect of recycle streams from thermal sludge treatment processes on the biological treatment process; or the effect an enclosed aerated grit chamber may have on the air handling system compared to a non-aerated system.

5. **Unit Process Selection.** Consider and evaluate all types of processes that perform the same function, such as circular vs rectangular vs square sedimentation tanks, or the different types of aeration devices.

SITE WORK AND LAYOUT

1. **Access Roads.** Ensure that roads maintaining the same functional access are located in a manner that minimizes the length of roads in order to save capital and maintenance costs.

2. **Road Widths.** Road widths should be commensurate with the projected traffic volumes. Table B-1 shows recommended widths.

TABLE B-1. RECOMMENDED ROADWAY WIDTHS

Design speed (mph)	Total roadway width, including shoulders (feet)			
	Little traffic		Frequent traffic	
	Few trucks and buses	Many trucks and buses	Few trucks and buses	Many trucks and buses
20	18	20	22	24
25	20	22	24	26
30	20	22	24	26
35	22	24	24	26

Notes: 1. Maximum pavement width is 24 feet; wider roadways include shoulders.
2. "Little" or "Frequent" farm machinery traffic is at the designer's discretion.
3. Percentage of trucks and buses is defined by average daily traffic:
ADT up to 50 vehicles - Low percentage is less than 28%
ADT 51 to 100 vehicles - Low percentage is less than 12%
ADT 101 to 200 vehicles - Low percentage is less than 7%
ADT 201 to 400 vehicles - Use high percentage figures only

American City & County: January 1980

3. **Road Design:** Evaluate the climatic conditions of the area, and ensure that the road bed to accommodates these conditions in combination with the projected traffic loads. It is frequently better to install a higher cost road initially to reduce future maintenance costs.

4. **Fencing.** Fencing around the plant site should be reviewed for quality and quantity. Areas that will be used for future expansion may not require fencing. Fencing materials should be consistent with area in which plant is located. Rural sitings may ony require wire barriers; whereas urban areas may require high security fencing consistent with local aesthetics.

5. **Yard Piping.** The location of influent/effluent piping, transfer piping and recycle piping should be examined in an effort to minimize the length requirements. Pipe sizes should have acceptable velocity ranges to maintain

solid suspension. In confined areas piping should be sized for projected ultimate flows. Wherever possible, the Return Activated Sludge/Waste Activated Sludge piping systems should be simplified with common discharge piping and suction headers as much as possible.

6. Landscaping. Review landscaping plans with maintenance requirements in mind For example, inclusion of sprinkler systems in arid areas and minimize area covered. Use ground cover such as bark chips or gravel as this doesn't require the attention of other plantings. Select plantings and grass that are suitable for the area, and require the least amount of care.

7. Site Layout. Locate proposed unit treatment processes in as compact a layout as possible. The more compact plants require fewer operator steps and shorter connecting piping.

8. Tunnels. Long lengths of underground tunnel should be eliminated unless they are constructed in conjunction with other structures since above ground walkways are often less expensive.

9. Handrails. Handrailings around certain open tanks or basins may be replaced with either chain link fences or, narrow concrete walls at lower unit costs. Tank walls can be utilized as the handrail by either bringing the walls up above the ground surface as appropriate (42-inches), or importing less fill for the site. Either of these alternatives could be used to yield an aesthetically pleasing appearance, and meet present OSHA standards.

10. Site Lighting. Site lighting needs should meet functional requirements. If security and full coverage lighting is required, consider high efficiency light fixtures.

SITE BUILDINGS

1. Buildings. Buildings of similar environmental conditions should be grouped together to take advantage of common wall construction, less heating, and more efficient movement and access between the different zones.

2. Building Space. Review space requirements for the specific plant. After making allowances for future expansions, any non-functional space may be deleted.

3. Building Materials. Evaluate available building materials to assure that the buildings use the most cost effective materials.

4. Building Architecture. Architectural finishes and materials should be selected to minimize construction and maintenance costs. Construction materials should be commensurate with the specific building's function, such as administration building compared to sludge handling building.

5. Buildings. Evaluate the potential for centralizing operations processes. Duplication of similar process around the site may be combined, such as one blower building. Assure access for equipment maintenance and removal. The

location and size of doors and windows should allow for equipment handling devices. Assure that adequate aisleways and clearances is provided for equipment and electrical panels. Evaluate energy requirements of materials in the exterior walls.

6. Roofing. Roofing systems are the most frequent cause of claims and litigation in construction. Roofing systems should be reviewed strictly for performance in the geographical area.

STRUCTURAL

1. Forming. Form work is generally the most expensive part of cast-in-place concrete. Complex forming for concrete tanks, basins or buildings should be minimized to reduce unnecessary construction costs.

2. Foundations. Review the geotechnical report for the proposed treatment facilites to evaluate the foundations for required structures.

3. Slabs. Review alternative methods for designing the thickness of basin bottom slabs. Consider slab-on-grade with minimum load transfer capability.

4. Groundwater. Evaluate groundwater levels at the site of the treatment facilities. Review the uplift forces associated with structures and basins and the placement of pressure relief devices.

5. Walls. Basin and tank walls design should minimize concrete/steel requirements. Walls for water retaining structures require special attention to minimum cover over steel and other construction details to ensure a water tight structure.

6. Materials. Evaluate construction materials for compatibility with the anticipated environmental conditions. Structures over high humidity areas, such as over clarifiers or aeration basins, should be carefully evaluated since steel members may require exotic coatings.

EQUIPMENT

1. Pumps. Consider the proposed application of the type and size of pumps. For example, closed impellor pumps would not be used for fluids that contain sludge or other solids.

2. Pumping Systems. Evaluate the potential for combinating pumps for optimum operations. A standby unit should be included to provide for failure or maintenance. Consider the mix of constant and variable speed pumps to minimize both capital and O&M costs.

3. Bearings. Evaluate the bearing life for equipment such as clarifier mechanisms, surface aerators or others, that typically are used continuously.

4. Gearboxes. When reduction gear boxes are required for equipment operation, such as for surface aerators, evaluate the impact load capability.

Frequently, these systems experience severe shock loads (due to transient loads) that are substantially higher than the rated motor horsepower.

5. Standby Units. Consider utilizing flow equalization storage in lieu of installing standby equipment throughout the plant. This may not be practical for large treatment facilities, but a simple economic analysis can quickly demonstrate the feasibility.

6. Equipment Units. Evaluate the potential for optimizing the number and size of each type of equipment item used in the treatment process. Normally, fewer items of equipment will result in lower O&M costs without unduly affecting flexibility and reliability.

MECHANICAL

1. Valves. Plug valves should be used for wastewater and sludge lines. These valves seldom clog and are self-cleaning which results in lower O&M requirements.

2. Pipe Materials. Evaluate the use and location of the piping pipe materials. Less expensive pipe often can be used where ductile iron or steel pipe have been used historically.

3. Floor Drains. Floor drains should be installed in all buildings and structures. Water may be caused by equipment drainage, pipe rupture, washdown practices or spills.

4. Clean Outs. All sludge piping should have cleanouts. Consider including similar maintenance features on all other wastewater lines.

5. Ventilation. Ventilation systems should be capable of removing heat from operating equipment and providing a safe environment for plant personnel.

6. Pipe Flexibility. Sufficient flexible couplings should be installed in the piping system so that equipment, pipe and valves can be removed.

7. Vibration Isolators. Vibration isolation dampers should be included for all high speed or large equipment items.

8. Acoustics. The estimated noise levels in all equipment rooms should be evaluated to determine if sound attenuation materials is needed to reduce the ambient noise levels.

ELECTRICAL, INSTRUMENTATION AND CONTROLS

1. Distribution. Evaluate the distribution voltage around the treatment facility. Frequently 5kV or 15kV distribution values are cost-effective for large sites.

2. Luminaires. Review the luminaires selected for lighting to determine if high intensity discharge (HID) or low intensity discharge (LID) luminaires should be used for large areas.

3. Motor Voltage. Examine the voltage selected for high horsepower electric motors (200 hp and above). Frequently, 2,300 volt or 4,000 volt motors are more cost-effective than 460 volt motors since capital and operation and maintenance costs tend to be lower for the higher voltage motors.

4. Variable Speed Drives. Evaluate the necessity of variable speed drive installation in the treatment facility. These are frequently installed in locations that could be served by constant speed drives. Variable speed drives typically consume more energy although the overall energy use at the facility may be less.

5. Computer. Examine the total costs and performance reliability of including a computer in the treatment facility. The analysis should include all costs associated with operating and maintaining the computer, which requires specialized technical abilities. Computer sytems are rarely justified on an economic basis, and are often installed as a result of technical considerations. Computer operation of a treatment facility has been shown to reduce operational labor requirements up to 40 percent, but maintenance costs may offset this saving. Computers have proven to be effective for administrative purposes and for scheduling and tracking maintenance requirements. The size/capacity of the computer is directly related to the number of interface points, which many times include points for analytical data which are rarely, if ever, used.

6. Control. Evaluate the process control system's ability for manual control and monitoring of the facility since all systems will inevitably go down for one reason or another.

ENERGY CONSERVATION

1. Recovery of Anaerobic Digester Gas. Digester (sewage) gas can be used as the fuel for space heating, digester heating, on-site generation of electricity, engine driven pumps or blowers, or any other in-plant purpose requiring fuel. Another alternative for larger facilities is to clean and sell the gas to local industry or a gas company as low heat fuel.

2. Waste Heat Recovery. Recoverable waste heat is often generated by engines, blowers, compressors, and furnaces or incinerators. Specially designed heat exchangers can be installed to use waste heat for space heating, to supplement anaerobic digester heating requirements, or other similar purposes.

3. Cogeneration. Cogeneration is the concept whereby electricity generated on-site is supplied in parallel with the main outside power source. Any excess electrical energy generated flows back into the power company's distribution grid, while electrical needs in excess of the amount generated is supplied by the power company. This type of system is generally applicable to areas having high electrical costs and for medium to large capacity treatment plants.

4. Heat Pumps. Some of the heat contained in sewage effluents can be recovered through the use of heat pumps. Water to water or water to air may use the effluent as either the heat source or sink. These systems can be used for space heating or cooling, of a low temperature water loop or to pre-heat fluids that are to be heated to higher temperatures.

5. Active Solar Collection: This type of system requires that a working fluid (air, water or a water/glycol mixture) be continuously pumped through solar collectors to adsorb solar energy (heat) and then to a storage system (large tank of water, bed of rocks or some combination) to release the absorbed heat. These systems can be used for space heating and cooling, water heating and to supplement anaerobic digester heating requirements.

6. Passive Solar Collection: These differ from the active systems in that there are few moving parts and little equipment is required. They are used normally to augment space heating requirements. Typically, the system consists of translucent panels of glass, plastic or fiberglass separated from a heat absorbing wall or panel by an air gap. Either the wall, or the air in the air gap, or a combination of the two is heated from the sun's energy passing through the translucent panels which in turn augments the space heating.

MISCELLANEOUS

1. Corrosion. Evaluate the corrosive potential of the soils at the plant site and the suitability of the materials.

2. Security. Consider the security needs of the treatment facility and evaluate the measures necessary to ensure that security level.

3. Storage. Evaluate the specific locations of the storage areas and their ability to adequately protect the stored items.

4. Odor Control. Review the odor potential from all areas of the treatment faciliites and evaluate any possible public relation problems.

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